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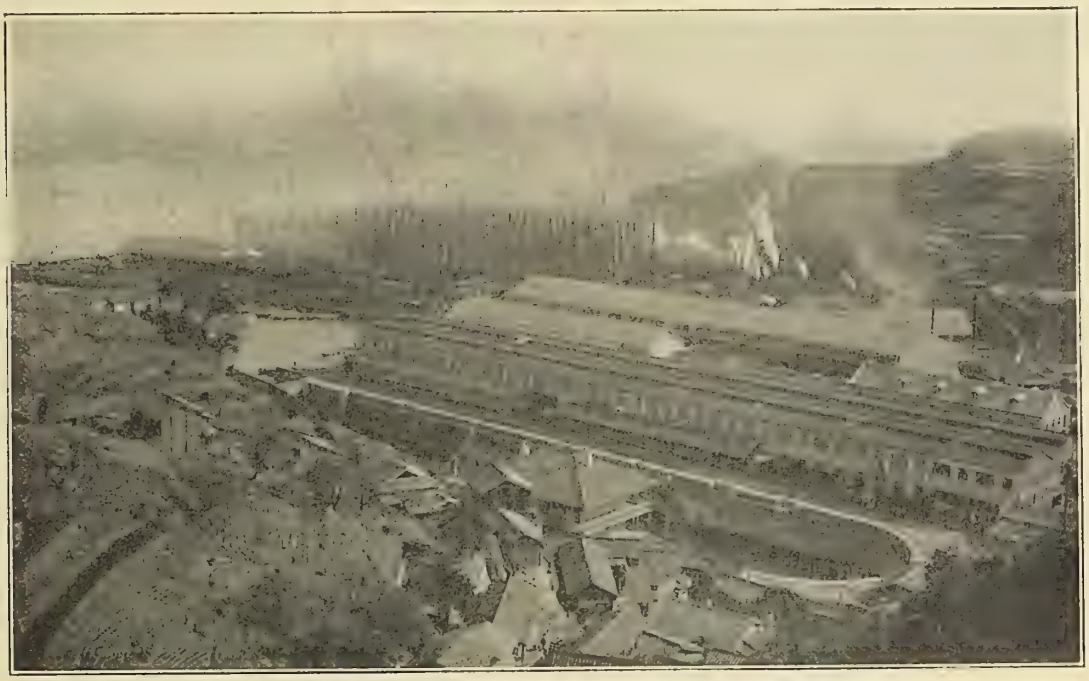
THE MITSU-BISHI DOCKYARD AND ENGINE WORKS.

The Mitsu-Bishi Company, of Japan, under the presidency of Baron Hisaya Iwasaki and the vice-presidency of Baron Koyata Iwasaki, having its headquarters at Tokyo, owns two shipbuilding and engineering works, one at Nagasaki and the other at Kobe. The company is sole licensee for manufacturing Parsons' marine steam turbines and turbo-generators in Japan, China and Korea. The following brief description will afford a means of judging of the equipment and capacities of the two plants.

THE NAGASAKI WORKS.

The Mitsu-Bishi Dockyard and Engine Works is one of the oldest and largest shipbuilding and engineering establishments in Japan, if not in the East. It is not only one of the largest, but it is equipped with the most varied tools for the production, without subcontracting, of every type of ship, machinery and boilers for land and marine use, steel girders, steel buildings and electrical machinery. Its specialties are Parsons' marine steam turbines and turbo-generators, Stone's manganese bronze castings and Morison's Contraflo condensers.



GENERAL VIEW OF SHIPYARD AND DRYDOCK NO. 1, AT NAGASAKI.

Many shipbuilding firms are content to construct the more important items of the ship, depending to the fullest extent upon outside establishments, where particular items of work are specified. The principal commendation for this practice is that there is less capital involved in the plant, consequently less loss incurred during the periods of depression which recur regularly.

The Mitsu-Bishi Works, on the other hand, like Barrow or Clydebank Works of Great Britain, is laid out with the object of doing the maximum of work upon any ship, purchasing from outside sources only the materials and those articles which may be termed "proprietary" items, where inventions and patents are largely involved. The advantage in this case is that there is not only economy in production under one management, but there is less likelihood of the separate items being delayed in delivery, and therefore interfering with the consecutive progress of the building of the ships. Moreover, there is no better way for the Mitsu-Bishi Works to adopt than this system, for, although Japan is rapidly advancing, the supplementary industries for ship and engineering works are yet in their infancy, and therefore cannot be depended upon for the best work.

HISTORY OF THE WORKS.

The works has a very interesting history of its own, it was founded by the "Shogun" Government in 1856. Dutch engineers were employed, and the necessary machines and gears for commencing the works were imported from Holland. A portion of jetty, where the giant crane now stands, was constructed then by means of an old-fashioned diving bell of Dutch make, which apparatus still remains in the works in memory of the founders. Work was then carried on only in a very small scale for repairing small steamers owned by the "Shogun." At the Restoration the works came under the control of the Public Works Department and were very much extended. In 1871, a large dry dock at Tategami, now called No. 1 dock, was constructed, and the patent slip at Kosuge, then owned by a British merchant, was purchased, and from time to time the works were considerably developed. In 1883, a wooden steamer named *Kosuge Maru,* of 1,500 tons gross,

was built as a forerunner of the shipbuilding industry in Japan.

In 1884, on the abolition of the Department of Public Works, the establishment and the various subsidiary works connected with it were purchased by the Mitsu-Bishi Company, who started this branch of business with only 800 men, and three years later the first iron steamer, of about 206 tons gross, the *Yugawo Maru,* was built, followed by three steel steamers, *Chikugogawa Maru, Kisogawa Maru* and *Shinanogawa Maru,* each about 700 tons gross, also a steel steamer, *Suma Maru,* of 1,592 tons gross, was built in 1895, which was considered then as an epoch of the shipbuilding industry of the works. But the true development dates from the termination of the Chino-Japanese War. In 1896 a great stimulus was given to the growth of shipping and shipbuilding in Japan by the enactment of the Navigation Encouragement Law and the Shipbuilding Encouragement Law. About this time the Nippon Yusen Kaisha first organized its European line, and decided to build six steamers of 6,000 tons each. The construction of one of these steamers was undertaken by the works, and it was finished in 1898. This was the first large steamer built in Japan, but subsequently many large vessels were built, including turbine transpacific liners of 13,500 tons, destroyers, despatch boats, etc. On the other hand the Mitsu-Bishi Company has kept the works from time to time supplied with the most improved appliances and gears. A number of staffs were despatched to the European engineering centers, to learn up-to-date methods of construction and organization of engineering enterprises, and a number of British experts were engaged as technical advisers and instructors. Immediate returns were considered as of secondary importance, the whole aim of the firm being to equip an establishment of which Japan might be proud both in workmanship and in business integrity, so that it has now grown to the position of being the most important works in the Far East. The accompanying tables afford some evidence of the work done during the last 12 years by this company.

TABLE I.—ANNUAL PRODUCTION OF THE MITSU-BISHI CO. DURING THE LAST TWELVE YEARS.

Year.	No. of Vessels.	Engines.	Gross Tons.	I. H. P.	Average No. of Workmen per Day.
1898	4	4	7,703	4,225	3,430
1899	12	12	4,007	3,189	3,558
1900	13	9	11,617	13,519	3,792
1901	6	6	7,194	6,238	5,209
1902	9	6	15,807	13,336	5,193
1903	8	8	13,078	11,463	5,658
1904	7	5	11,859	12,082	5,292
1905	9	7	12,973	12,731	6,745
1906	13	11	10,031	22,735	8,871
1907	4	4	7,859	23,519	9,669
1908	4	4	23,332	36,417	9,011
1909	4	4	29,596	33,379	5,703

TABLE II.—NUMBER AND GROSS TONNAGE OF VESSELS DOCKED DURING LAST TWELVE YEARS.

Year.	Dry Dock.		Slip.	
	No. of Vessels.	Gross Tonnage.	No. of Vessels.	Gross Tonnage.
1898	84	254,069	19	3,539
1899	95	272,146	29	9,042
1900	103	260,269	32	9,271
1901	111	283,977	30	10,013
1902	76	177,418	31	10,121
1903	47	133,840	20	5,295
1904	65	155,279	26	6,271
1905	117	352,758	22	7,776
1906	97	385,834	26	8,167
1907	90	243,808	17	3,928
1908	39	135,606	17	3,672
1909	57	148,102	13	1,657

GENERAL ARRANGEMENT OF THE WORKS.

The establishment is situated on the inner harbor of Nagasaki and extends along almost the whole length of the western shore of the harbor, having a water frontage of about 8,000 feet, and covering an area of over 114 acres, with numerous workshops and dry docks equipped with all the latest and most up-to-date machine tools and appliances for shipbuilding, engineering, drydocking and electrical engineering work. There are powerful hydraulic and electrical installations, as well as pneumatic plants for the lighter class of work in riveting, calking, chipping, etc.

The works may be said to be constituted of four principal sections, viz., shipbuilding yard, engine works, drydocks and slip.

The shipyard at Tategami, which is at the outer end of the harbor, has seven building berths, ranging from 240 feet to 700 feet long, and an annual output capacity of over 30,000 tons. The mold loft, scrive boards, plate and angle-bending shops, plater's machine shops, smith shop, galvanizing shop and machine shop are arranged in this yard. The joiners', cabinet makers', polishing and woodworkers', upholstery department and others associated with shipbuilding are all laid out contiguous to the building yard and on a very extensive scale, and furnished with the latest and most improved equipment.

The engine works at Akunoura, which is at the inner side of the harbor, covers a large area and embraces erecting and fitting shops, the boiler shop, machine shop, turbine shop, electric shop, blacksmith shop, coppersmith shop, pattern and foundry shops, etc. Most of these are adequately fitted with electrically-driven overhead cranes of different capacities.

Between the shipyard and engine works there are three dry docks, the largest of which can accommodate vessels up to 714 feet on the keel, 84 feet beam and 34 feet 6 inches draft, making it one of the finest and largest graving docks in existence at the present day.

A patent slip, capable of lifting ships up to 1,000 tons gross, is situated on the other side of the harbor, opposite the shipyard.

ADMINISTRATIVE DEPARTMENT.

The administrative department, or main office, is situated at Akunoura and on the main entrance to the engine works in three blocks of substantial brick building.

The basement of the front block contains the mess room for draftsmen, and boiler room for steam heaters. The first floor has the board room, private office of the general manager, and corresponding and secretarial office and the telephone room. The second floor is entirely occupied by the estimate engineer's office, involving purchase, estimate, counting and general statistical departments. On the floor above is situated the drawing office for admiralty work. It is 84 feet by 31 feet, and has an accommodation for 25 ship draftsmen and 25 engine draftsmen. The basement of the left wing contains the main time office, book and cashier department, the first floor has the main engine drawing office, which is 69 feet by 47 feet, with an accommodation for 110 draftsmen, and the second floor has the ship drawing office, with accommodation for 42 draftsmen. Each drawing office has a large fireproof safe at one end of the office, in which the drawings are all classified and stored. The floor above includes a completely equipped photographic department, with six large sun-printing frames and one Hall's continuous electric copier. The basement of the right wing contains the work's police department and engine work's time office, while on the first floor there is a series of offices for admiralty overseers and other superintendents.

It may be mentioned here that there is a second ship-drawing office at the shipyard, which is 120 feet long by 40 feet broad, containing the detail and decorative departments; in the former the smith work, castings and all fittings are dealt with, while in the latter all decorative features of the ship

KOBE PLANT. VIEW OF SEA FRONT FROM NORTHEAST.

are worked out. These two departments are specially situated in the shipyard, so as to be contiguous to the ships under construction and to the joiner and cabinet maker's, upholstery and decorative painter's work shops. This office has an accommodation for 60 draftsmen and is equipped with a photographic room and a large fireproof safe. Therefore the ship drawing office has a staff of 127 draftsmen in all under the charge of the chief ship draftsman, who also has charge of the experimental tank.

The engine works manager has an office close by the main office, and in the same building there is an electrical engineer's drawing office, with an accommodation for 15 draftsmen.

The shipyard manager has an office in Tategami, with a time office in the vicinity. There are also a number of rooms for Lloyd's surveyors, government surveyors and shipowner's superintendents in the same building.

A system of telephonic communication is in use throughout the works, so that vast as is the establishment, its organization overcomes any of the disadvantages of distance. There is a regular method of storing the materials in readiness for the various sections.

THE BUILDING BERTHS AND LAUNCHING GROUND.

In describing the works it may be more interesting to review the departments and plants in the order of their use and importance in the building of the ship rather than to adopt an itinerary method. The works have seven building berths, as follows:

	Feet.
No. 1. Berth for vessels up to	680
No. 2. Berth for vessels up to	700
No. 3. Berth for vessels up to	580
No. 4. Berth for vessels up to	460
No. 5. Berth for vessels up to	340
No. 6. Berth for vessels up to	300
No. 7. Berth for two vessels up to	240

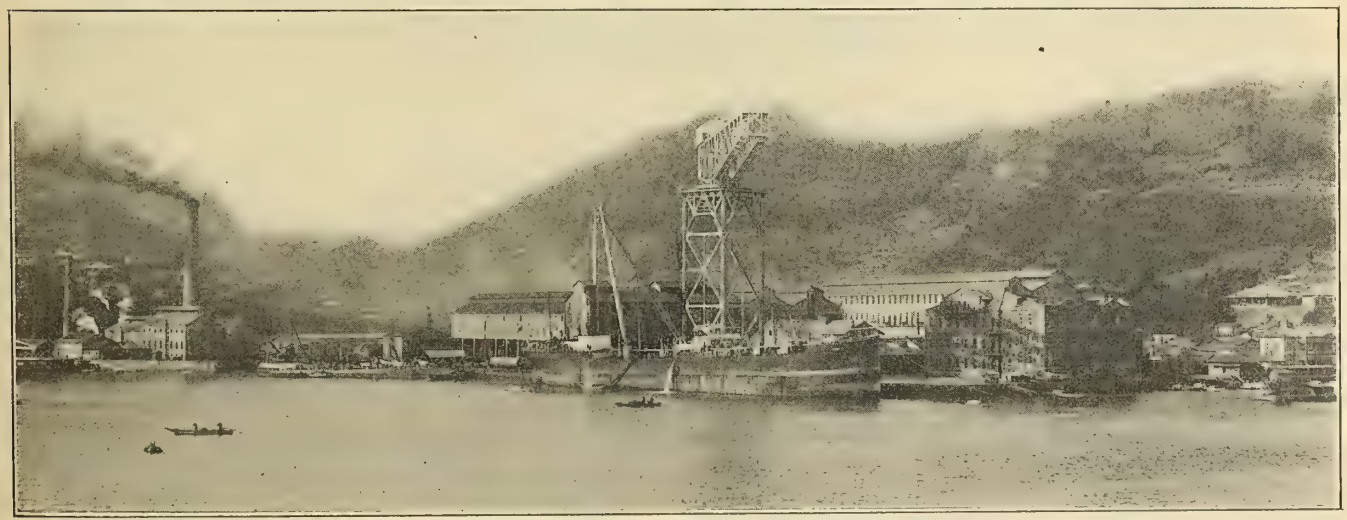
Several of them have been constructed with a view of supporting the concentrated weight due to modern warships.

As regards the length, only a small quantity of drags and checks will be required for sending afloat the largest vessels, as there is plenty of harbor space at the end of the building berths. The berths are well equipped with powefrul jib cranes at frequent intervals, capable of lifting weights up to 3 tons on board during construction. There are several locomotive cranes throughout the yard, ranging from 5 to 3 tons. They are also used for stocking ship plates and angles, etc., from the lighters, and for subsequently lifting them from the racks and passing them to the tracks for conveyance to the plater's sheds, etc. To facilitate the conveyance of materials there are in the yard over 2½ miles of rails.

SHIP PLATERS' AND FITTERS' DEPARTMENT.

Dealing with the separate departments, one naturally begins with the mold loft, where the work of construction is begun in the case of all ships. The length of the loft is 380 feet, and its width 70 feet, the roof being of light steel principals, with corrugated iron on the purlins, with ample daylight admitted by the glazed top and sides. The space below the loft is used partially as a scrive board, and partially as a plater's machine shop.

In the frame-bending shop, which is about 140 feet square, there are two angle furnaces, each 66 feet long, and one plate furnace 30 feet long, and two angle beveling machines, with about 4,800 square feet of cast iron blocks for setting the frames as well as the scrive boards for laying them out.



NAGASAKI ENGINE WORKS, SHOWING 150-TON GIANT CRANE.

The plater's machine shops, which cover an area of over 54,070 square feet, are equipped with 14 punching and shearing machines, ranging up to tools which shear 1½-inch plate and punch 1½-inch holes in the same thickness, while the gap is 36 inches, enabling plates 6 feet wide to be worked on. There is one hydraulic manhole punch capable of working holes 28 inches by 20 inches. There is a large hydraulic flanging machine for setting plates for the keel and garboard strakes, as well as for stiffening flanges in bulkheads; it is capable of dealing with plates up to 24 feet and up to a thickness of 1 inch. There are three bending rollers dealing with plates up to 25 feet long. The planing machines number eight, and are all of considerable capacity. For straightening there is one mangle, with solid steel rollers, taking plate 6 feet wide and 1 inch thick. There are also a plate scarphing machine, joggling machine, hydraulic bar cutting machine, etc. There are nine countersink drilling machines. Almost all of the tools in this shop are of British make, and the majority of them are worked from shafting driven by electric motors.

The beam-bending shed is 90 feet long by 35 feet broad, and in it there are one beam-bending and punching machine, two beam-bending machines, one beam-bending and angle-cutting machine, one angle and channel-cutting machine, two cold iron saws, etc., all operated by electricity.

The iron workers' shed is on the south side of the yard, and contiguous to the building berths; it is 85 feet long by 65 feet wide, containing one angle-cutting and plate and angle-planing machine, one countersink drilling machine, one plate-bending and straightening machine, two plate-straightening and flattening machines, two punching and shearing machines, etc.

The blacksmith shop, which is 262 feet long by 40 feet broad, contains 35 smith fires, the blast being supplied by three Root's blowers; there are 10 steam hammers ranging up to 20 hundredweight, and one 5 hundredweight steam striker, also three rivet-making machines, the largest of which is capable of turning out 3 tons per 10 hours.

The angle smith shop is 175 feet long and 40 feet broad, and contains 28 fires, with two centrifugal fans driven by electricity.

The galvanizing shop is adjacent to the blacksmith shop. The building is 110 feet long and 40 feet wide. There are five zinc baths, the largest being 22 feet by 2 feet 2 inches by 5 feet, one refining furnace and four water baths.

The machine shop is placed contiguous to the building berths. The shop is 140 feet long by 60 feet broad. There are 14 drilling machines of varied type, also the same number of lathes of varied type. Other machines include a boring and turning machine, shaping machine, slotting machine, milling surface planing machine, cold iron band sawing machine, Selber patent screwing machine, screw-cutting machine, bolt and nut-screwing machine, lag-screwing machine and emery grinding machine, etc. The machinery in this shop is driven by two electric motors, each of 40 brake-horsepower.

GENERAL VIEW OF MACHINE AND ERECTING SHOPS AT NAGASAKI.

WOOD-WORKING DEPARTMENT.

As can readily be imagined, in an establishment which sends out first class passenger steamers the wood-working department is very extensive. The whole timber department occupies about 5 acres of ground, about one-third of which is covered in with drying sheds. The timber for the joiner department is accommodated in sheds covering 3,800 square

yards. The buildings for deck stowage cover 1,760 square yards.

The saw mill is situated at the extreme north end of the shipyard. The building is of light, wooden structure, measuring about 100 feet long by 70 feet broad. The log department is fitted with three vertical saw frames. In the reconversion and resawing of the wood, the principal machines used are two four-side planing machines, one circular saw endless band sawing machine, reciprocating cross-cut saw and dowel-making machine, etc. In the saw room there are two saw-sharpening machines and one band saw sharpening machine. The majority of the machinery in the mill is driven by electricity.

The joiners, cabinet makers and polishers are accommodated in a two-story building, situated at the side of No. 1 dock. It covers a working space of 80,440 square feet. The collection of wood-working tools is complete and representative of best British practice, including circular saw bench, three endless band saws, scroller fret saw, planing machine, power and hand-feed planing machine, three planing and jointing machines, scraping machine, eight molding machines of various- types, dove-tailing machine, five sandpapering machines of different types, buffing machine, two tenonning machines, five mortising machines, rounding machine, two wood-turning lathes, wall-drilling machine and emery grinding machine, etc. The machinery is driven by four electric motors of 146 total brake-horsepower.

The carpenters' shops, which are on the other side of No. 1 dock, cover an area of 18,750 square feet, and contain planing, molding and drilling machines, also an endless band saw, all driven by electricity.

THE GRAVING DOCKS AND SLIP.

There are three graving docks and one slip. No. 1 dock is the one nearest to the shipyard, then No. 3 and No. 2; they are all constructed of granite, and the slip is at Kosuge. It may be mentioned here that No. 1 dock was constructed by the former owner, but was lengthened by the present proprietor in 1895.

The following are the principal dimensions of docks:

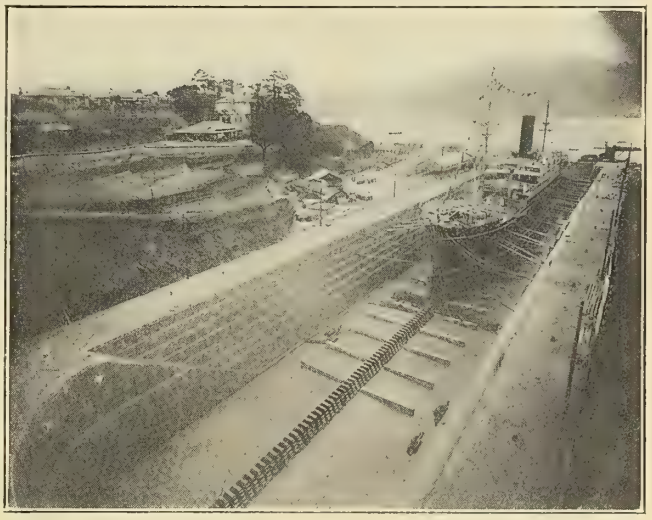
NO. 1 DOCK.	
Length on keel blocks.....	510 feet
Breadth at entrance on top.....	89 feet
Breadth at entrance on bottom	77 feet
Depth of water on blocks at ordinary spring tide.....	26 feet 6 inches
NO. 2 DOCK.	
Length on keel blocks.....	350 feet
Breadth at entrance on top.....	66 feet
Breadth at entrance on bottom	53 feet
Depth of water on blocks at ordinary spring tide.....	24 feet
NO. 3 DOCK.	
Length on keel blocks.....	714 feet
Breadth at entrance on top....	96 feet 7 inches
Breadth at entrance on bottom	88 feet 7 inches
Depth of water on blocks at ordinary spring tide.....	34 feet 6 inches

The patent slip is capable of lifting vessels up to 1,000 tons gross, the length of rail is 750 feet, with a width of 30 feet.

THE ENGINEERING DEPARTMENT.

We may now turn to the engineering department, which is arranged at the northern part of the works. The machine shops, which cover an area of about 23,150 square feet, contain 124 lathes, 3 turning and boring machines, 5 screwing machines, 5 cutting-off machines, 1 nut-tapping machine, 1 bolt-turning machine, 1 stud machine, 9 planing machines, 7 shaping machines, 6 slotting machines, 1 keyway cutter, 32 drilling machines, 3 centering machines, 1 cylinder boring machine, 3 boring machines, 2 oil groove cutting machines, 15 milling machines, 1 nut side-facing machine, 2 band sawing machine, 1 circular sawing machine, 16 grinding machines.

Of the above special mention should be made of one electric-driven quadruple-geared crankshaft turning lathe, having a height of centers of 54 inches, and a length of bed of 42 feet, admitting between centers 27 feet 3 inches; two treble-geared shafting lathes, each having a height of centers of 20 inches, and length of bed of 36 feet 6 inches, admitting between centers a length of 28 feet, these having a common center line, when combined together are capable of turning up to 68 feet 6 inches; one electric-driven vertical cylinder boring machine, capable of boring cylinders up to 100 inches in diameter, one electric-driven double-headed universal horizontal drilling, boring, tapping, studding and milling machine commanding 10 feet vertically and 20 feet horizontally, with spindle 5½ inches in diameter, also one horizontal and vertical planing machine having a horizontal stroke of 21 feet, and a vertical stroke of 18 feet, driven by 25 brake-horsepower motor.



OPENING OF GRAVING DOCK NO. 3, AT NAGASAKI.

The machine shop is equipped with one 20-ton, one 15-ton and three 5-ton electric overhead traveling cranes.

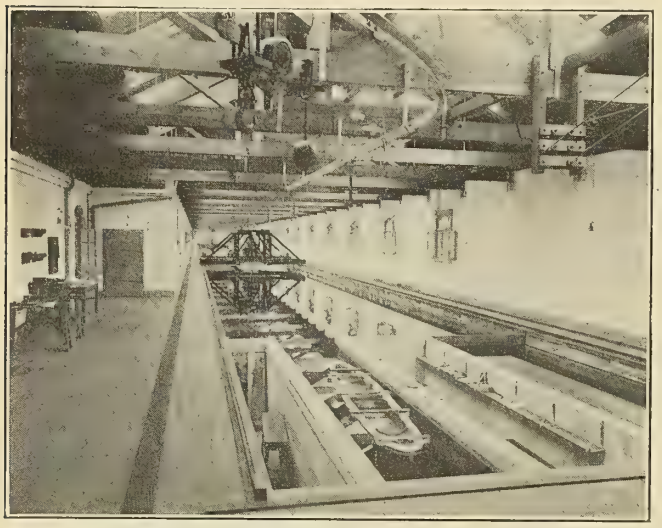
The turbine shop, which is 243 feet by 102 feet, contains 4 lathes, 1 turning and boring mill, 2 planing machines, 1 slotting machine, 1 turbine machine, 1 turbine blade-cutting machine, 4 drilling machines, 1 turbine cylinder boring machine, 1 turbine blade-nicking machine, 1 turbine packing strip cutting machine, 1 special dove-tail milling machine, 1 special milling device, 5 turbine blade-tipping machines. Special features among the above machinery are one large electric-driven quadruple-geared double-bed lathe for turbine rotor turning, having a height of centers of 68 inches, which may be raised to 79 inches by using a lever, and a length of bed of 51 feet admitting between centers a length of 36 feet; one electric-driven pit-planing machine capable of planing 36 feet in length, 14 feet 6 inches in width and 7 feet 6 inches in height. One electric-driven turbine cylinder boring machine, to bore up to 13 feet, and one electric-driven powerful slotting machine having a stroke of 48 inches.

The machinery in this shop is all driven by electricity. There are two 50-ton and one 60-ton electric overhead traveling cranes.

ERECTING SHOP AND MACHINE SHOP.

The building is 67 feet 11 inches by 116 feet 2 inches, and is very lofty. There are three main bays, which are occupied respectively by the electric shop, erecting shop and fitting shop. The erecting shop has sufficient space to erect three twin sets of 8,000 indicated horsepower triple-expansion engines simultaneously, and is equipped with one 30-ton and one 20-ton electric overhead traveling crane. The fitting shop is equipped with one 10-ton crane of the same type.

The water testing and "shrink-on" work shop, which is 80



EXPERIMENTAL TOWING TANK AT NAGASAKI.

feet by 130 feet, is equipped with a complete set of pumps and gear for water testing and shrinking-on work, and 20-ton electric overhead traveling crane.

BOILER SHOPS.

The boiler shops are situated in juxtaposition to the turbine shop, the buildings cover an area of 53,282 square feet of ground, and are divided into four sheds, one for machine work, one for boiler construction, one for hydraulic riveting and the other for flanging. There are several very powerful tools, notably one 125-ton hydraulic riveter, with an 8-foot gap, served by a 40-ton hydraulic crane; one 150-ton hydraulic flanging machine, with 4-foot gap; one vertical plate-bending roller, to deal with a plate 11 feet 6 inches wide and 2 inches thick; one electrically-driven boiler shell drilling machine, which can take one double-ended boiler up to 16 feet in diameter and 18 feet in length, or two single-ended boilers, each of 12 feet 6 inches long, with a diameter of 16 feet; one two-spindle boiler shell drilling machine, to deal with boilers up to 16 feet in diameter and 18 feet in length; one four-spindle boiler shell drilling machine, to deal with boilers up to 16 feet in diameter and 23 feet 6 inches in length; one electrically-driven lever punching and shearing machine, with an angle cutter capable of punching 1½-inch holes through 1½-inch plate, shears 1½-inch plate and cuts angles 6 inches by 6 inches by 1 inch, with punch gap 36 inches and shear gap 33 inches, and a one-edge planing machine capable of planing plates up to 30 feet horizontally. Besides the above special features of this shop are one large 30-ton portable hydraulic riveter, with 7-foot gap and one oval and round hole cutting and marine boiler flange and flue turning machine, to take boiler end plates from 7 feet 6 inches to 17 feet in diameter, and one portable electrically-driven drilling and boring machine. As for conveyance, the shop is equipped with four 40-ton and one 7-ton electric overhead traveling cranes, two 5-ton hydraulic wall cranes and eleven hand wall cranes, ranging from 1 to 5-ton lifts.

The engine works smith shop, which is 375 feet by 60 feet, is a light steel structure, with twenty-three single hearths, five double hearths and seven forges, arranged in rows on either side of the building, and with nine steam hammers ranging from 1¼ tons to 7 tons arranged in the center line. There are 5-ton, 10-ton and 20-ton air furnaces. The shop is equipped with twelve cranes ranging 1½ tons to 20 tons. There is also one steam-driven plate-shearing machine.

THE COPPERSMITH SHOP..

A temporary building, 144 feet long by 72 feet wide, is equipped with one hydraulic pipe-bending machine, one upright drilling machine, one horizontal radial drilling and tapping machine, one flange rolling, straightening and circular cutting machine, one punching machine, one capstan lathe, one hack saw, one air hammer, one plate-bending roll, one pipe-threading machine and one shearing machine. There are twelve hearths, the blast being supplied by a Root's blower, with a 31 brake-horsepower electric motor, and capable of supplying 640 cubic feet of air per minute.

FOUNDRY.

The foundry is situated to the north of the machine shops. It consists of two main parts, the iron and steel foundry and the brass foundry. The iron and steel foundry is 310 feet long by 102 feet wide. The equipment includes a 2-ton Siemen's steel gas furnace, four cupolas, with a casting capacity of 50 tons, one annealing furnace and three drying furnaces, each 20 feet long and 16 feet wide, and one sand mill. Two 15-ton and one 30-ton electric overhead traveling cranes and fourteen 3-ton radial cranes are distributed conveniently. There are six molding pits, the two largest being 25 feet by 30 feet by 7 feet and 20 feet by 20 feet by 12 feet, respectively.

The brass foundry is 100 feet long by 102 feet wide, containing two Stone's manganese air furnaces of 8 and 5 tons capacity, with a molding pit 12 feet by 12 feet by 7 feet on

FLOATING DOCK NO. 2, AT KOBE.

the iron and steel foundry side, so that the heavy overhead cranes in the iron and steel foundry may be utilized for this pit. There are six brass crucibles of forced draft and four of natural draft, each of 200 pounds, and two drying ovens. There are eight radial cranes of 3 tons each distributed over the foundry. At the corner of the brass foundry there is a core shop.

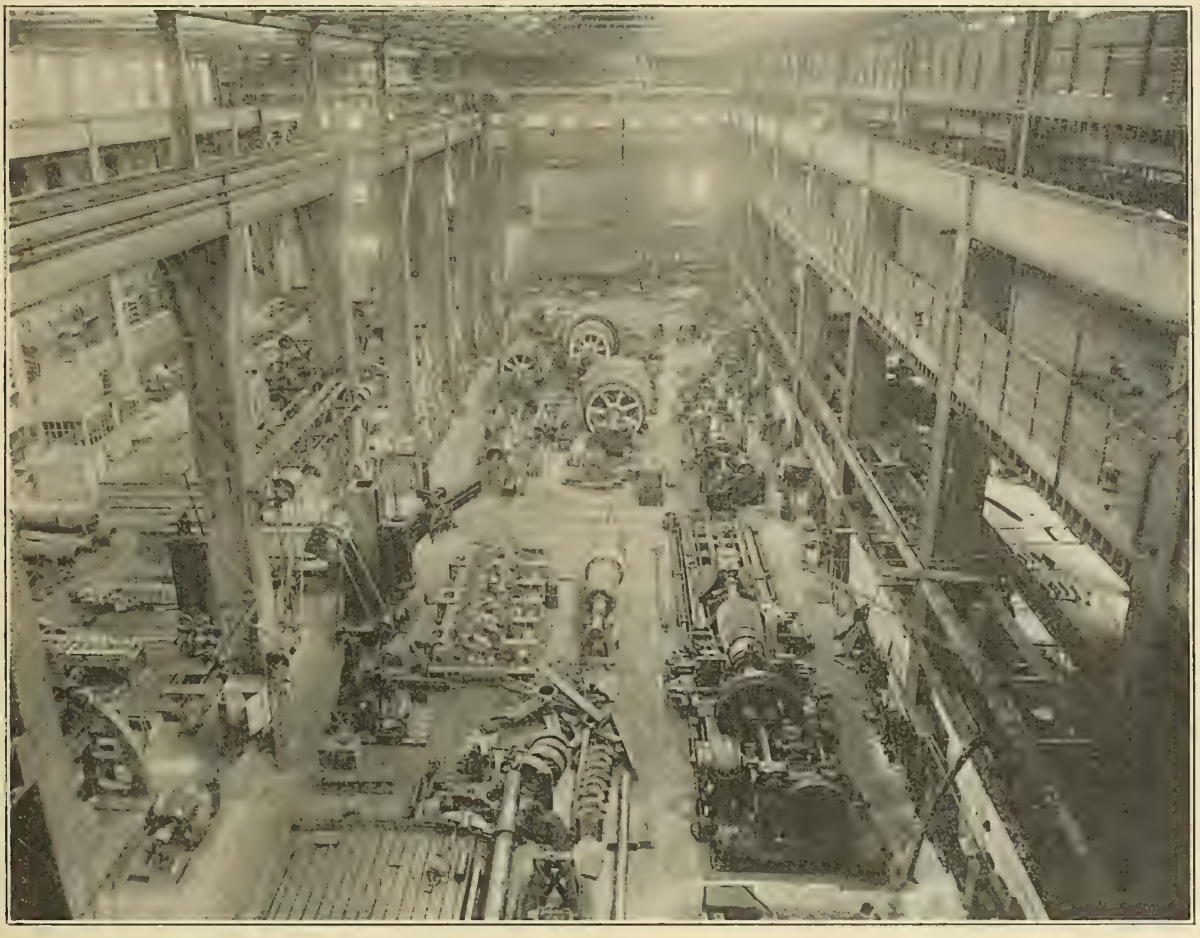
The foundries are entirely self contained, molding boxes and plates, core bars and core irons, etc., are all made in the same place. Adjoining the foundries there are the requisite stores for metal, sand, furnace coal, coke, etc.

The pattern shop, which is a brick building, 180 feet long

by 70 feet wide, is equipped with one circular and one band saw, one planing machine and four wood lathes, all driven by electricity. The first floor is used for stowing the patterns, there is also at the back a spacious pattern store for stowing large old patterns.

On the jetty for shipping engines and boilers, etc., from the engine works, there is a 150-ton Titan type giant crane, by Messrs. Applebys & Company. It consists of a square tower, 136 feet 3½ inches in height and 40 feet square at the base, carrying a large roller path on top, upon which a horizontal jib having a total length of 239 feet 9¾ inches is supported. The long arm of the jib has a total radius of 156 feet 6 inches. The work is also provided with a 30-ton floating shearlegs.

is fitted with two 500-kilowatt turbo alternators, direct coupled to Parsons turbines; one 500-kilowatt direct-current generator, coupled to a Willans patent central valve engine; two 100-kilowatt direct-current dynamos, coupled to the same type of engines; two 225-kilowatt direct-current dynamos, coupled to a McIntosh vertical cross-compound engine, one 300-kilowatt direct-current dynamo, coupled to a three-phase induction motor; two 25-kilowatt dynamos, coupled to one three-phase induction motor and used for ship lighting, and a 100-kilowatt booster or motor generator, which is used for charging the secondary batteries, whose capacity is 3,000 ampere hours. Steam is supplied by seven Babcock & Wilcox boilers, which also serve as destructors, being used for dispos-



GENERAL VIEW OF THE TURBINE SHOP AT THE NAGASAKI PLANT.

EXPERIMENTAL TANK.

The plant includes a splendidly equipped ship model experimental tank, designed by Mr. Archibald Denny, of Dumbarton, and which is practically a reproduction of the Clydebank tank, which was fully described in volume XIV of International Marine Engineering. The waterway extends for 430 feet, of which 380 feet is deep, varying from 12 feet 6 inches at the north end to 12 feet at the south end. The breadth is uniformly 20 feet. The tank carriage is electrically driven, the trolley wiring being on the Ward Leonard system. The tank carriage, with its apparatus and model cutting machine and other accessories for the tank work, was constructed and supplied by Messrs. Kelso & Company, Glasgow.

POWER PLANT.

Electricity is used on an extensive scale, not only for the lighting of workshops, sheds, the interiors of ships under construction, and of the yard generally, but also for the driving of the machine tools. The central power house at Akunoura,

ing of the sawdust, shavings, etc., from the various woodworking shops and the rubbish collected from the interiors of ships under construction.

The sub-station at Tategami shipyard is fitted with two 200-kilowatt rotary convertors and six 75-kilowatt transformers, and converts from 3,450 volts alternating current to 250 volts direct current.

Arc lamps are used principally for outside illumination and in the interior of the larger sheds and shops. Incandescent lamps are used in all the woodworking departments and offices and for all bench work. They are also adopted for the internal lighting of ships during construction. Adequate hydraulic and pneumatic power plants are installed.

The works are supplied with a modern apprentice school, hospital and club house for the benefit of the workmen.

THE KOBE PLANT.

The Kobe plant of the Mitsu-Bishi Dockyard & Engine Works was begun in August, 1905, and after various prepara-

tions for reclaiming the land, constructing the breakwater, etc., had been done, No. 1 floating dock of 7,000 tons lifting capacity, built at the company's Nagasaki works, was towed into the basin, but to meet the growing business an extension on a large scale soon became a matter of urgent necessity, and before the second anniversary the keel blocks for No. 2 floating dock of 12,000 tons lifting capacity were laid down, and also some permanent steel buildings for work shops were in the course of construction. The works have steadily grown, until at present they are fully equipped with the latest machine tools and appliances, mostly of English make, suitable for the construction of a vessel of 10,000 tons.

The plant is situated on the western shore of the harbor of Kobe, and just northward of the Wada-Misaki lighthouse at the entrance of the port, and it has been laid out on a liberal scale, covering an area of about 82 acres in order to provide room for expansion. The sea frontage is more than 5,000 feet long, and a part of it is reserved for shipbuilding berths suitable for the simultaneous construction of seven vessels of over 500 feet in length; and on the north of the building berths there is a basin having an area of about 13 acres, protected by a breakwater of masonry work 1,000 feet long, leaving an opening for the entrance from the north, the opening being naturally sheltered by the shore of Hyogo, which lies at a distance of a little over half a mile.

Along the basin a masonry quay wall was constructed for the purpose of mooring vessels under repairs or when fitting out. A 100-ton steel tripod shearlegs has been lately erected on the foundation laid on the quay wall; and there are four strong mooring buoys outside the breakwater, forming a safe deep-water anchorage; and as the establishment is connected with Wada branch line of the Imperial Government Railway the works occupies a unique position in the harbor in reference to communication with both land and sea.

The principal work shops, which are equipped with electric power and light, and are inter-connected by railway tracks, which are also in connection with the government line, include machine and erecting shops, shipyard machine shops, blacksmith, boiler, carpenter, pattern, coppersmith's, electrical machinery and bending shops, brass and iron foundries, mold loft and sawmill.

There are two power houses, in one of which are two generators of 100 and 150-kilowatt capacities each, driven by Parsons steam turbines, and in the other a 450-brake horsepower Cockerill gas engine, driving one 300-kilowatt generator built in the works, the gas being supplied by a Mond gas producer of 800-brake horsepower capacity, which will also supply gas to the furnace in the blacksmith ship.

Finally, in concluding this description, it will be interesting to British and American readers to know that both in the Nagasaki and Kobe works the specifications and wording in drawings, books, charts, forms, orders, etc. in fact every bit of writing in the establishment is in English, besides a greater portion of the correspondence. Indeed it is rather curious to notice a workman carrying out the work to the letter with a drawing worded entirely in English, while he is unable to quote a simple intelligible sentence.

We are informed by Messrs. William Mills, Ltd., Atlas Works, Sunderland, of an inaccuracy in the description of this firm's engaging and disengaging boat gear in our article entitled "Life Saving at Sea," issue of October, 1910. The article states "This apparatus enables the boat to be released before it is water borne." An important feature claimed by the manufacturers is that this gear cannot be disengaged until the boat is in the water and very nearly water borne.

Repairs to end plates and other parts of boilers where grooving or cracking occurs can effectively be made by the oxy-acetylene process of welding.

THE ECONOMICAL WORKING OF RECIPROCATING MARINE ENGINES AND THEIR AUXILIARIES. *

BY D. B. MORISON.

APPENDIX A.†

The following are the particulars of some experiments conducted upon the steam engine in the Laboratory of the Glasgow and West of Scotland Technical College, with the object of ascertaining what effect an increase in vacuum has upon its steam consumption and horsepower.

The engine is a horizontal cross-compound, the high-pressure and low-pressure cylinders being 12 inches and 21 inches diameter respectively, with a stroke of 30 inches, and in the case of these tests there was no receiver between the high-pressure and low-pressure cylinders.

The admission and exhaust valves are of the drop-piston type, and during the trials the admission pressures and the points of cut-off in both cylinders were as far as possible kept constant.

The revolutions of the engine were also maintained at a constant rate by altering the brake resistance for the different conditions of vacuum. The low speed of revolution, 80 per minute, is accounted for by the fact that the trials here presented were part of another series. Had the engine been run at its normal speed, 110 revolutions per minute, the steam consumption per horsepower per hour would have been less.

The cylinders are not in any way specially designed for working with a high vacuum, but are of ordinary design suitable for the moderate vacuum usually expected in this type of compound engine.

It will be seen that as the vacuum increases both the steam used per hour and the brake-horsepower increase. It is easy to see why the horsepower should increase, but the effect of vacuum upon steam consumption is rather more difficult to understand. With increased vacuum there is a remarkable fall in the pressure and consequently in the exhaust pressure in the high-pressure cylinder. Due to this fall of pressure there are three separate ways in which the steam per stroke is increased. In the first place the weight of steam enclosed in the high-pressure clearance volume at compression is diminished, and so an extra quantity of fresh steam per stroke is required to make up for this diminution. The difference between the high-pressure steam chest and exhaust pressure is increased and consequently there is an increased amount of valve leakage. Also the mean temperature of the cylinder walls is lowered and there is more initial condensation. With a triple or quadruple expansion engine the effect upon the high-pressure exhaust pressure would be much less marked, and consequently there would be little increase in the steam used per stroke or per hour with increased vacuum. It was determined from the experiments that by raising the vacuum from 20 inches to 28 inches the steam consumption decreased 22 pounds to 20.3 pounds per hour per brake-horsepower, a diminution of 1.7 pounds per brake-horsepower hour over a range of 8 inches of mercury.

This is equivalent to a decrease in the steam consumption of 7.8 percent over the range mentioned, or an increase in economy at the rate of practically 1 percent per inch increase of vacuum in the condenser from 20 inches to 28 inches vacuum.

The temperature of the air pump discharge has been ignored, but it is obvious from the foregoing that in the case of a marine engine considerable economy may be gained even in a two-stage compound engine by working with a high vacuum and heating the feed by means of the auxiliary ex-

* Concluded from the February issue.
† Communicated by Prof. A. L. Mellanby, D. Sc., of the Glasgow and West of Scotland Technical College.

haust steam which otherwise would go to the condenser direct, and the economy resulting from the application of this system to triple and quadruple engines would, of course, be much greater.

It should be noted that the above experiments relate only to the particular engine tested and the results would not compare with those obtainable from a marine engine specially designed for obtaining the highest economy from high vacuum. The low-pressure cylinder indicator diagrams taken from this engine are shown in Fig. 15.

APPENDIX B—THE EFFECT OF VACUUM UPON THE STEAM ECONOMY OF TRIPLE-EXPANSION HIGH-SPEED ENGINES.*

The observations detailed in the following notes were made during the official steam consumption trials of a triple-expansion high-speed engine.

The primary object was to ascertain the extent to which the fully measured by weighing the water discharged by the air pump, in accordance with the method recommended by the Institution of Civil Engineers' Committee on Steam Engine and Boiler Trials.

All the conditions were kept as constant as possible throughout, with the single exception of the degree of vacuum.

During each trial indicator diagrams were taken from all cylinders, in order that the mean pressures might be ascertained, as well as for purposes of comparison.

Every care was taken in connection with the weighbridge measurements, the apparatus being so located as to permit of one observer weighing the exhaust while keeping the tachometer and dynamometer steel-yard in full view.

In these circumstances any variation in either the brake load or the revolutions per minute would at once be detected, so that the figures obtained must correspond very closely to actual values.

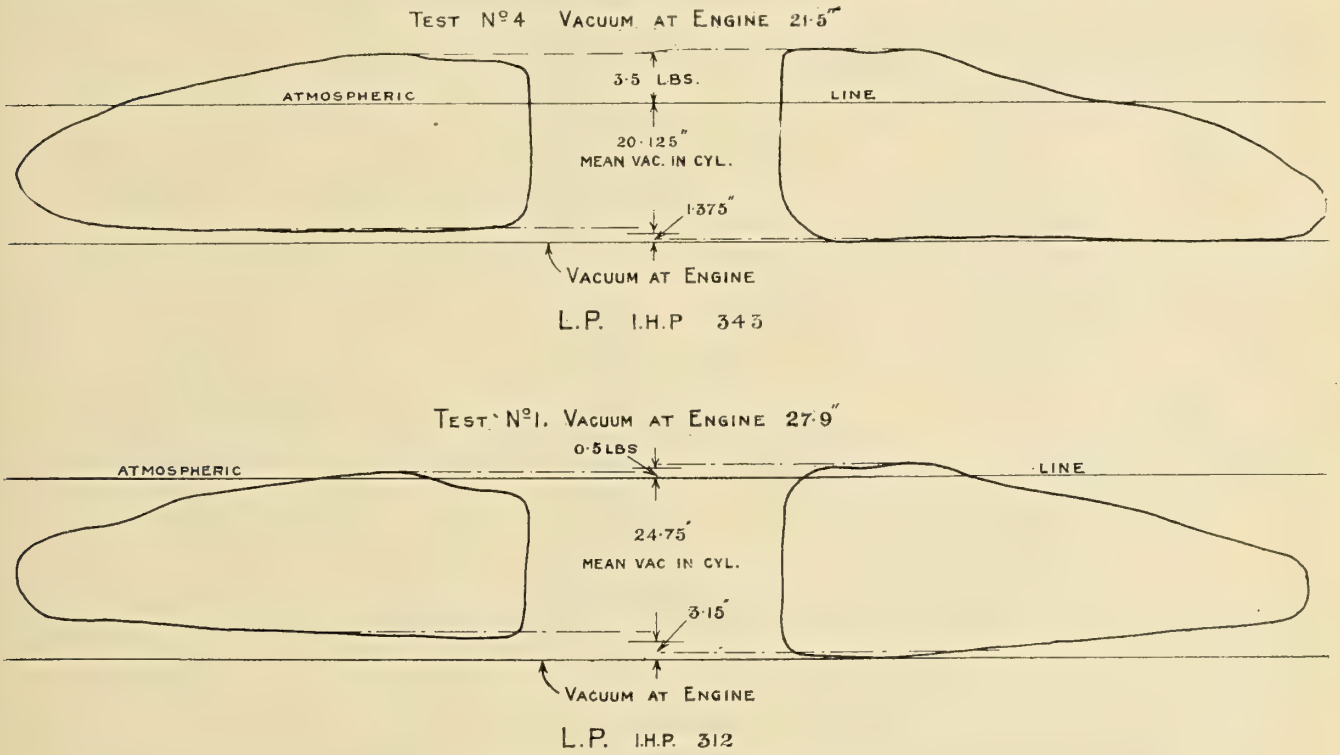


FIG. 12.—L. P. INDICATOR DIAGRAM TAKEN DURING SPECIAL TRIALS FOR EFFECT OF VACUUM ON STEAM CONSUMPTION.

economical performance of the engine could be influenced by reducing the exhaust pressure.

The engine used for the purpose of the trials was one of eight similar sets intended for dynamo driving and designed to develop a normal full load of 1,080 brake-horsepower when running at 250 revolutions per minute. Forced lubrication was supplied for crank shaft and motion work bearings, the leading dimension of the engine being as follows:

	Inches
Diameter of high-pressure cylinder	18½
Diameter of intermediate-pressure cylinder	27
Diameter of low-pressure cylinder	40
Stroke of pistons	20

Piston valves throughout.

During the period of the trials the engine was exhausting through a short range into a surface condenser having motor-driven circulating pump and steam-driven Edwards air pump.

The consumption of steam at the various vacua was carefully measured by weighing the water discharged by the air pump, in accordance with the method recommended by the Institution of Civil Engineers' Committee on Steam Engine and Boiler Trials.

All the conditions were kept as constant as possible throughout, with the single exception of the degree of vacuum.

During each trial indicator diagrams were taken from all cylinders, in order that the mean pressures might be ascertained, as well as for purposes of comparison.

Every care was taken in connection with the weighbridge measurements, the apparatus being so located as to permit of one observer weighing the exhaust while keeping the tachometer and dynamometer steel-yard in full view.

In these circumstances any variation in either the brake load or the revolutions per minute would at once be detected, so that the figures obtained must correspond very closely to actual values.

All the readings and diagrams were taken with the engine developing the full load of 1,080 brake-horsepower.

Four steam consumption tests were made, and the results are given in the tabulated statement on page 99 from which the relative influence of vacuum variation will readily be seen.

The indicator cards reproduced above are photographed from the original diagrams (see Fig. 12).

Preparatory to making the first trial, the dynamometer was adjusted until the steel-yard "floated" at the correct load. The exhaust connections were then examined in order to suppress any possible source of air leakage, the vacuum at the engine being brought up to 27.9 inches. (Barometer, 30 inches.)

When the conditions were constant, the steam consumption was carefully measured, indicator diagrams being taken from all cylinders, and the various pressures and temperatures noted at regular intervals.

On the completion of this trial, the vacuum was reduced until the condenser pressure rose to 26.8 inches vacuum, when a further steam consumption test was taken along with diagrams and other data. Additional tests were made at 25.8 inches and 21.5 inches vacuum.

* Communicated by Mr. R. K. Morcom, M. I. M. E. (Messrs. Belliss, Morcom & Co., Ltd.)

The comparative figures relating to these trials are given in the tabulated statement on page 99.

From this statement it will be seen that by raising the condenser vacuum from 21.5 inches to 27.9 inches, the steam consumption was reduced from 14.15 pounds per brake-horsepower per hour to 12.55 pounds, a saving of 1.60 pounds per brake-horsepower hour, or approximately 11.3 percent. The corresponding increase in vacuum being 6.4 inches, the steam consumption of this engine per brake-horsepower would ap-

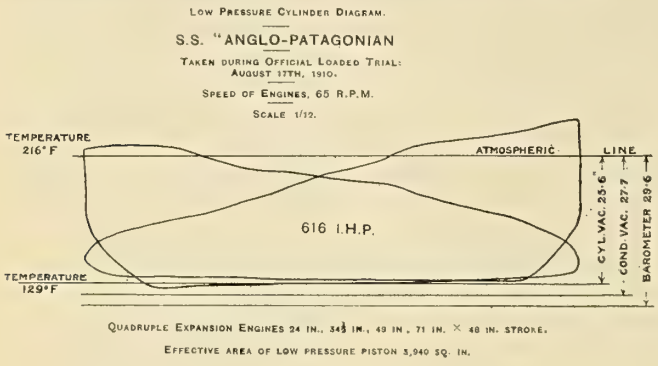

Low Pressure Cylinder Diagram.
S.S. "ANGLO-PATAGONIAN
Taken during Official Loaded Trial: August 17th, 1910.
Speed of Engines, 65 R.P.M.
Scale 1/12.
TEMPERATURE 216° F
ATMOSPHERIC LINE
616 I.H.P.
CYL. VAC. 25·6"
COND. VAC. 27·7
BAROMETER 29·6
TEMPERATURE 129° F
Quadruple Expansion Engines 24 in., 34½ in., 49 in., 71 in. × 48 in. Stroke.
Effective area of low pressure piston 3,940 sq. in.

FIG. 13.

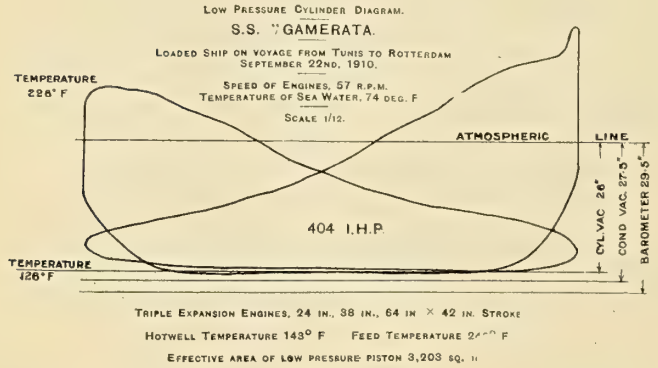

Low Pressure Cylinder Diagram.
S.S. "GAMERATA.
Loaded Ship on voyage from Tunis to Rotterdam September 22nd, 1910.
Speed of Engines, 57 R.P.M.
Temperature of Sea Water, 74 deg. F
Scale 1/12.
TEMPERATURE 228° F
ATMOSPHERIC LINE
404 I.H.P.
CYL. VAC. 26"
COND. VAC. 27·5"
BAROMETER 29·5"
TEMPERATURE 126° F
Triple Expansion Engines, 24 in., 38 in., 64 in. × 42 in. Stroke
Hotwell Temperature 143° F
Effective area of low pressure piston 3,203 sq. in.

FIG. 14.

pear to increase at the rate of, say, 1.77 percent, for each reduction of 1 inch in the condenser vacuum.

The tabulated statement is corrected for differences in degree of superheat.

Referring to the low-pressure cylinder indicator diagrams (see Fig. 12) and tabulated statement (page 99), it will be seen that the vacua given are those corresponding with the condenser pressures obtaining at the time cards were taken. For an increase in condenser vacuum of 6.4 inches the low-pressure cylinder power fell from 343 to 312 indicated horsepower, a reduction of 31 indicated horsepower, or at the rate of, say, 4.85 indicated horsepower per 1 inch additional vacuum.

If the engine had no governor, the increased vacuum would be productive of (1) higher speed, (2) greater total steam consumption per hour, (3) augmented power output.

Usually with expansion governing, the power developed by the low-pressure cylinder for a given total load would not increase for a reduction in the terminal pressure, because the earlier cut-off in the high-pressure cylinder would generally more than neutralise any such tendency.

In the case of this particular set, the shaft governor controls the engine both by throttling the steam and varying the cut-off, to accomplish which the slide valve has inclined ports, and may be rotated automatically so as to vary the lap.

As the percentage cut-off in the high-pressure cylinder may be directly read from a suitably divided indicator plate attached to the expansion gear, the cut-offs at high and low vacua were noted, the readings being given in the tabulated statement.

At the low vacuum (21.5 inches) the mean cut-off in the high-pressure cylinder was .45, at high vacuum (27.9 inches) the cut-off was automatically reduced to .4. As the diminished cut-off would necessarily be accomplished by a closing of the throttle valve (both motions being taken from the one lever), the relative position of the cut-off gear affords interesting and conclusive proof as to the absolute effect of increased temperature range upon the steam consumption of this engine. Even if the weight of steam used had not been ascertained by careful measurement, the position of the cut-off gear and governor valve would have roughly indicated the steam economy consequent upon the higher vacuum.

This may be further verified by an inspection of the low-pressure cylinder indicator diagrams (see Fig. 12), from which it will be noted that the receiver pressures are very considerably higher at a vacuum of 21.5 inches than at 27.9 inches, an effect consequent upon the relative positions of throttle valve and expansion gear at constant brake load and revolutions per

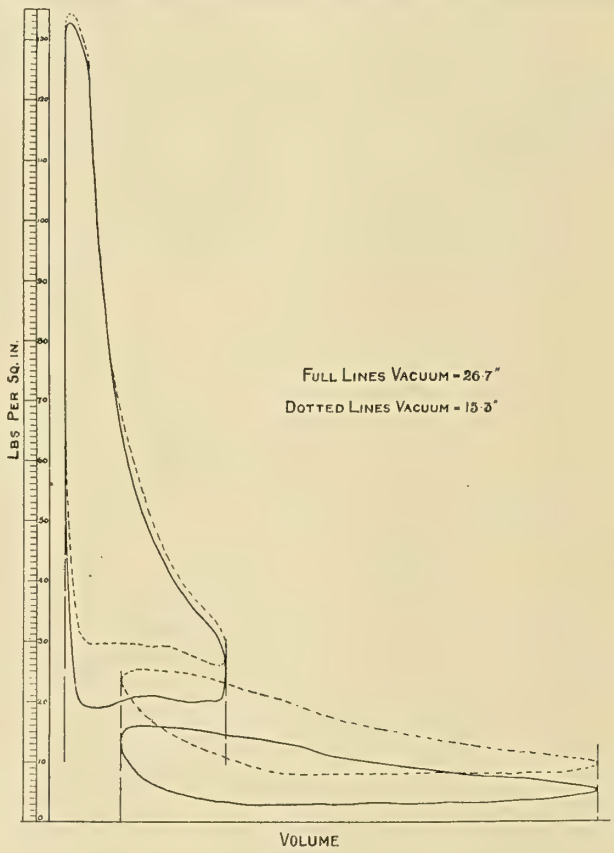


FIG. 15.

minute. This further explains why the low-pressure power does not necessarily fall off with increased back pressure.

In making the trials, outlined in the foregoing, every care was exercised with a view to accurate determination of the economy in steam due to higher vacuum.

The brake used was a Froude water dynamometer, and as the engine ran at full load throughout, the brake conditions were such as to be constant in a degree quite exceptional in commercial engine testing.

Two Crosby indicators were employed, the cocks being screwed directly into the top and bottom ends of the cylinder. These instruments were carefully cleaned and oiled, all the diagrams being taken by the same observer. The drums were driven from stout piano wires kept in tension by a stiff spiral spring.

The vacuum was measured on a mercury column which was checked against an absolute pressure barometer.

EFFECT OF VACUUM ON THE STEAM CONSUMPTION OF A 1,080 B. H. P. QUICK REVOLUTION BELLISS TRIPLE EXPANSION ENGINE.

These trials were made at a steady load of 1,080 B. H. P. and at 250 revolutions per minute, the water being measured at air pump discharge.
Cylinder diameters, 18½", 27" and 40"; stroke, 20".

Test number	1	2	3	4
Steam pressure at engine's stop valve (pounds per square inch gage)	188	186	188	188
Steam pressure at engine's stop valve (pounds per square inch gage) at H. P. chest	183	180	185	183
Indicated horsepower—H. P.	451	461	431	416
Indicated horsepower—I. P.	366	353	369	390
Indicated horsepower—L. P.	312	320	323	343
Indicated horsepower—Total	1,129	1,134	1,123	1,149
Steam temperature, degrees Fahr.	474	455	478	482
Superheat, degrees Fahr.	91	73	95	99
Cut-off in H. P. cylinder	0.4	.....	.....	0.45
L. P. initial pressure from diagrams (pounds gage)	0.5	.....	.....	3.5
Vacuum at engine, inches	27.9	26.8	25.8	21.5
Steam consumption, pounds per B. H. P. hour, actual	12.7	13.2	12.83	14.16
Steam consumption, pounds per B. H. P. hour, corrected to 100 degrees Fahr. superheat	12.55	12.68	12.74	14.15

APPENDIX C.*

The following data, obtained from the T. S. S. *Indrabarah*, owned by Sir Thomas Royden, Bart., and built to our designs, may be of interest.

This vessel has just completed her first outward passage to Australia fully loaded.

The vessel is of the three-shelter deck type of the following dimensions:

Length between perpendiculars..470 feet
Breadth extended ..... 58 feet
Depth molded ..... 43 feet to shelter deck

and has been built by Messrs. Swan, Hunter & Wigham Richardson, Ltd., at Wallsend-on-Tyne, and engined by Messrs. Richardsons, Westgarth & Co., at their Hartlepool Engine Works. Her total displacement at a load draft of 28 feet 10¼ inches is 17,025 tons.

She is insulated for the carriage of cargoes of chilled and frozen meat, and is fitted with a compound duplex CO_2 machine (the size of which appears later) capable of dealing with an insulated capacity of 292,380 cubic feet.

Her engines are of the twin-screw triple-expansion type, each having cylinders 22 inches, 37 inches, and 62 inches, with a stroke of 45 inches, and are capable of indicating 5,000 indicated horsepower at 95 revolutions per minute; there are four single-ended boilers fitted with forced draft having a total heating surface of 11,192 square feet and working at 200 pounds pressure per square inch.

The design of these engines is based on the principle that the most economical and efficient results will be obtained by the adoption of such cylinders as will enable the engines to be run at their full-designed power without linking up and at a high piston speed; with the Contraflo system of high vacuum and temperature regulation in combination with cylinders provided with suitable proportions of steam and exhaust passages.

The installation of engine-room auxiliaries is unusually large; this comprises independent feed pumps, feed filter, feed heater, evaporator, distiller, dynamo, sanitary pump, fresh water pump, two centrifugal pumps, two fan engines, ballast pump, refrigeration circulating pump, telemotor steam-steering gear, as well as the CO_2 machine, which has cylinders 16 inches and 29 inches diameter by 21 inches stroke, all of which are in daily use.

The propellers are of bronze, and of the solid type.

On trials the vessel attained a speed of 14 knots on a six-hours' run at a draft of 18 feet mean and a displacement of 10,209 tons. The indicated horsepower was 4,850 and gives an Admiralty coefficient of 272, which is remarkably high for a vessel of this type.

In considering the result from the point of view of economical consumption for the speed obtained, it must be borne in mind that the model to which the ship was built has proved to be particularly good.

On the first outward passage the vessel attained a mean speed from London to Melbourne of 12.46 knots on an average draft of 26 feet 3 inches, or a displacement of 15,300 tons and an indicated horsepower of 4,600 at mean revolutions 85.2, the Admiralty coefficient being 260.

The best day's run was 325 nautical miles in twenty-three and a half hours or 13.8 knots, the Admiralty coefficient being 350.

The coal supplied was North country "Mickley" unscreened, giving about 11 percent ash, and the total consumption per twenty-four hours, including all auxiliaries, was 66.33 tons or about 1.34 pounds per indicated horsepower per hour of North country coal, equal to 1.23 of best Welsh coal, a result which is, in our opinion, very remarkable, having regard to the large number of auxiliary engines taking steam from the main boilers, and which, if deducted, would bring the rate of consumption per indicated horsepower for the main engines only to an exceedingly low figure.

The most striking feature of the indicator cards is the high vacuum shown in the cylinder, the exhaust line being within about 2 inches of the condenser vacuum up to a condenser vacuum of at least 28 inches.

The low-pressure ports and exhaust passages were carefully proportioned to insure a low resistance by giving a clear and unrestricted passage for steam without excessive clearance or pockets for its lodgment.

In conclusion, we would state that we attribute the economical running of the above engines to the following causes:

(1) High vacuum and ability to maintain it in high temperature sea water.

(2) Utilising the exhaust steam from the auxiliaries to heat the feed water up to the maximum temperature at which it can be dealt with by the feed pumps.

(3) The provision of such a capacity of cylinders and boilers as will enable the boilers to provide ample steam at full power without being unduly pressed, and as will enable the engines to run at their full-designed power and mean pressure without being linked up as is common in marine practice.

(4) Comparatively high piston speed.

The above results were obtained, not under the artificial conditions of a trial, but under sea steaming condition, and during a first voyage, which makes them all the more worthy of notice.

APPENDIX D—QUADRUPLE EXPANSION ENGINES AND HIGH VACUUM.*

The advantageous extension of temperature range being a leading characteristic of the quadruple engine, the lower limit of temperature is obviously a most important factor, especially when it is remembered that the upper limit of temperature remains constant at constant boiler pressure. Therefore, the question of vacuum arises, since, other things being equal, it is upon the vacuum that the temperature range will depend.

Quadruple machinery designed to work normally at a high ratio of expansion will necessarily give a relatively small mean pressure, so that in such circumstances successful operation may be readily prejudiced by imperfect vacuum. If the quadruple be worked at the highest vacuum to which the engine will respond, then there ensues a low condenser temperature. Such need not, however, produce a low temperature of feed,

* Communicated by Messrs. W. Esplen & Sons, consulting engineers, 31 James street, Liverpool.

*Communicated by Mr. R. J. Quelch, M. Inst. C. E. (Messrs. Lawther, Latta & Co.)

Vacuum and Temperature Readings taken by the Chief Engineer of the s.s. "Camerata."

On Voyage from Tunis to Rotterdam, September, 1910.

Date.	Vacuum Inches.	Temperature at Top of Condenser. Degrees Fahr.	Circulating Water Inlet. Degrees Fahr.	Temperature on Suction Side of Feed Pump.	Temperature on Discharge Side of Feed Pump.
Sept. 21 ...	27½	110	74	142	239
,, 21 ...	27½	110	74	143	239
,, 22 ...	27½	110	74	143	240
,, 22 ...	27½	110	74	143	240
,, 23 ...	27½	111	75	143	240
,, 23 ...	27½	110	74	142	240
,, 24 ...	27½	110	71	141	240
,, 24 ..	27½	109	68	142	240
,, 25 ...	27½	109	68	143	239
,, 25 ..	27½	110	67	142	239
,, 26 ...	27½	109	66	141	239
,, 26 ...	27½	109	66	141	239
,, 27 ...	27½	108	63	141	238
,, 27 ...	27½	108	61	141	238
,, 28 ..	27½	108	62	142	238
,, 28 ...	27½	108	63	142	239
,, 29 ...	27½	108	62	141	238
,, 29 ...	27½	107	61	140	238
,, 30 ...	27½	107	60	140	238
,, 30 ...	27½	106	59	140	238

if the auxiliary exhausts are condensed by the air pump discharge water.

In order that the most economical results may be obtained from quadruple and other multiple expansion marine engines, provision ought to be made for the maintenance of the requisite vacuum throughout the voyage, particularly at high expansion ratios. In this connection engineers are apt to forget that, so far as temperature range is concerned, variation in boiler pressure is of much less consequence than variation in exhaust pressure. It is uneconomical to work quadruple expansion engines at low vacuum; moreover, the means of condensation ought to be such that the exhaust pressure may be kept constant throughout tropical voyages. Generally, therefore, the maintenance of boiler pressure and of vacuum should be regarded as equally vital to successful practice in quadruple expansion engines.

It may be in point to refer to the quadruple engines of the *Anglo-Patagonian,* built to my designs and specification by the North-Eastern Marine Engineering Company, Ltd. These engines are 24 inches, 34½ inches, 49 inches, 71 inches by 48 inches stroke. The boiler pressure is 220 pounds per square inch. The condenser is of the Contraflo type, with temperature regulator, and the boiler feed pumps deliver the feed water through the tubes of a surface feed heater into which all available auxiliaries exhaust. On the occasion of the official loaded trials—Aug. 17, 1910—the total temperature range within the cylinders actually reached 263 degrees F., the higher limit of pressure being, say, 225 pounds absolute and the lower limit 2.16 pounds absolute. This is a very unusual result, particularly as the lower limit of temperature corresponds with the mean back pressure in the low-pressure cylinder, and not with the absolute condenser pressure. A low-pressure cylinder diagram taken during these trials is reproduced herewith (see Fig. 13).

The dimensions of the *Anglo-Patagonian* are: Length between perpendiculars, 403 feet; molded breadth, 52 feet; molded depth, 29 feet 1½ inches. The official loaded trials were taken with some 8,550 tons of bunker coal and stores on board, the vessel displacing about 12,120 tons. At this displacement the mean speed was 10.35 knots.

It ought perhaps to be added that the order of the results will be conditioned by the extent to which high condenser vacuum is maintained concurrently with high feed temperature.

APPENDIX E—TRIPLE EXPANSION ENGINES OF THE DJERISSA CLASS (LA TUNISSIENNE STEAM NAVIGATION CO., LTD.).*

There are three ships in the Djerissa class—the *Djerissa, Camerata,* and *Boukadra,* each of these vessels having a deadweight carrying capacity of about 6,200 tons on a displacement of approximately 8,800 tons.

The length between perpendiculars is 350 feet, the extreme breadth 50 feet and the depth molded 25 feet 11½ inches. The engines are triple expansion 24 inches, 38 inches and 64 inches by 42 inches stroke, with two boilers, 13 feet 6 inches mean diameter by 11 feet 6 inches long. The pressure is 180 pounds and the boilers work under forced draft.

Abstract from the Logs of the s.s. "Camerata." Voyage from Newport to Oran.
Mean Power Throughout the Voyage 1,080 I.H.P.

Date.	Pressure of Steam.	Inches of Vacuum.	Temperature. Feed to Boilers.	Temperature. Sea.	Revolutions per Minute.	Coal. Tons.	Coal. Cwts.	Coal. Description.	Distance. Propeller.	Distance. Observed.	Average Speed per Hour.	Slip per cent.	Buckets of Ashes per Day.
1910.													
Oct. 15 ...	175	27½	212	61	57	15	10	Welsh	173	166	8·9	4	75
,, 16 ...	175	27½	210	61	56	17	0	,,	219	158	6·54*	28	118
,, 17 ...	175	27½	211·5	62·3	57	17	0	,,	223	194	8·0	13	123
,, 18 ...	175	27½	211·3	63	57	17	10	Newcastle	223	225	9·3	nil	119
,, 19 ...	175	27½	211·6	65	57	17	0	Welsh	222	220	9·2	1	120
,, 20 ...	175	27¼	211	67·3	57	17	0	,,	220	230	9·7	nil	116
,, 21 ...	175	27¼	211	69·6	57	15	10	,,	186	182	9·1	2	78

* Strong wind and high sea, shipping water.

Coal used was of a fairly good steaming quality, rather fast burning and dirty. About 80 per cent. small. Clinker easily removed from bars and did not seem destructive to bars. The small cakes very well and does not run through the bars. Ash and dirt about 21 per cent.

The engineers are instructed to maintain high condenser vacuum and heat the feed by means of drainage water and vapor from the various cylinder and receiver drains, evaporator and feed heater coil drains, etc.

It is found that, notwithstanding the comparatiely high vacuum, the temperature of the hot-well water may be raised to the limit permitted by the feed pumps which are of the plain ram type driven from the main engines.

Service records from each of these steamers show that the vacuum within the low-pressure cylinder is from 25 inches to 26 inches, the condenser vacuum averaging from 27 inches to 27½ inches, when the steamers are on their regular Mediterrannean service in sea water temperatures up to 77 degrees.

* Communicated by Mr. A. Walker, M. I. N. A. of Messrs. F. Strick & Co.)

Abstract from the Logs of the s.s. "Boukadra." Voyage from Barry Dock to Naples.
Mean Power Throughout the Voyage 1,085 I.H.P.

Date	Pressure of Steam.	Inches of Vacuum.	Temperature.		Revolutions per Minute.	Coal			Distance.		Average Speed per Hour.	Slip per cent.	Buckets of Ashes per Day.
			Feed to Boilers.	Sea.		Tons.	Cwts.	Description.	Propeller.	Observed.			
1910.													
Sept. 13	180	28	224	63	59	9	10	Welsh	128	123	9·18	4	34
,, 14 ...	180	27	218	64	59	17	0	,,	231	225	9·32	2·5	117
,, 15 ..	180	27	218	64	59	17	0	,,	231	219	9·08	5	101
,, 16 .	180	27	222	66	59	17	0	,,	230	214	8·91	7	95
,, 17 ...	180	27	222	71	59	17	0	,,	229	219	8·75	8·7	75
,, 18 ..	180	27	218	71	59	17	0	,,	227	219	9·24	3·5	66
,, 19 ..	180	27	215	75	59	17	0	,,	227	204	8·59	10	78
,, 20 ..	180	27	218	76	59	17	0	,,	227	195	8·21	14	76
,, 21 ..	180	27	216	72	59	17	0	,,	227	214	9·02	5 7	80
,, 22 ...	180	27	220	76	59	17	0	,,	227	203	8·55	10 5	79
,, P.M....	180	27	220	76	59	7	15	,,	103	93	8·58	9	28

The coal used was Welsh Through of medium quality. Good steaming and slow burning. About 70 per cent. small made a heavy clinker which sticks to the fire bridges and is difficult to remove. The small cakes. Ash and clinker, 17 per cent.

The condensers (Contraflo type) have temperature regulators, and the hot-well water is passed through an air-discharging surface feed heater, so that in addition to being deærated, the feed water enters the boilers at a temperature of from 215 to 240 degrees F.

The arrangements are carried out with a view to providing the utmost simplicity, thereby minimizing the demand on the labor available.

Representative log abstracts are attached from which the general performance of each steamer may be estimated. Variation in the feed temperature as between either of the ships is due to there being means available whereby water from the bottom of the boilers may be circulated through the feed heater coils instead of steam.

A schedule of temperatures taken on the *Camerata* is also attached, together with a recent low-pressure cylinder diagram from the same steamer (see Fig. 14).

The average power maintained by the three ships is about 1,080 indicated horsepower, so that the engines are working at considerably less than the normal full load corresponding with the given dimensions. In these circumstances the system followed is to fully open all boiler and engine stop valves, running with maximum pressure in the high-pressure receiver and reduced cut-off.

The readings tabulated were, of course, taken during the respective watches and are subject to the margin of error which is normal to determinations made at sea.

It might be added that in these vessels the air and circulating pumps, as well as the boiler feed pumps, are all driven by levers from the low-pressure crosshead.

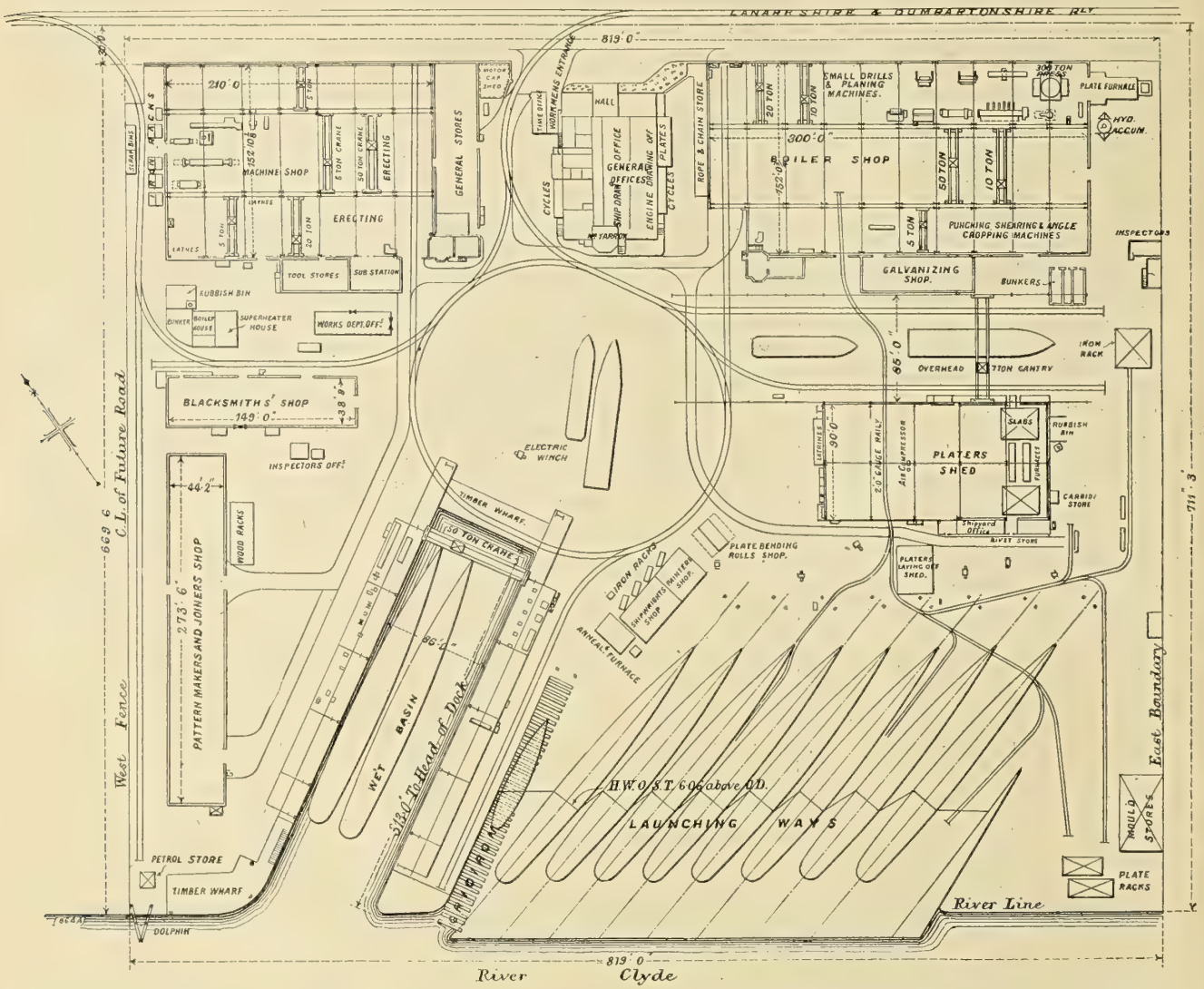
Abstract of Logs of the s.s. "Djerissa." Voyage from Dunston-on-Tyne to Barcelona.
Mean Power Throughout Voyage 1,060 I.H.P.

Date.	Pressure of Steam.	Inches of Vacuum.	Temperature.		Revolutions per Minute.	Coal.			Distance.		Average Speed per Hour.	Slip per cent.	Buckets of Ashes per Day.
			Feed to Boilers.	Sea.		Tons.	Cwts.	Description.	Propeller.	Observed.			
1910.													
Aug. 21 ...	170	27½	212	60	58	8	10	Newcastle	51	53	8·4	nil.	20
,, 22 ...	180	27½	212	60	61	20	10	,,	236	220	9·1	7	114
,, 23 ..	180	27½	224	63	58	18	0	,,	228	192	7·9	15	116
,, 24 ...	180	27½	223	62	58	18	0	,,	227	182	7·5	19	116
,, 25 ...	180	27½	224	65	58	17	10	,,	226	201	8·3	11	107
,, 26 ...	180	27½	224	67	58	17	0	,,	225	173	7·2	23	110
,, 27 ...	180	27½	226	68	58	17	0	,,	225	217	9·0	3·5	108
,, 28 ...	180	27½	228	67	58	17	0	,,	223	218	9·1	2·2	107
,, 29 ..	180	27½	236	74	58	17	0	,,	223	214	9·0	3·8	107
,, 30 ...	180	27½	138	77	58	17	0	,,	223	213	9·0	4·5	110
,, 31 ...	180	27½	138	77	58	12	5	,,	179	159	8·6	8·0	81

The coal used was Newcastle, quick burning, with 80 to 85 per cent. small. A good deal runs through the bars, which helps to form the large percentage of ash.

THE WORKS OF MESSRS. YARROW & COMPANY, LIMITED, SCOTSTOUN, GLASGOW.

When a few years ago Messrs. Yarrow & Company, Ltd., decided to move their works from the Thames at Poplar to Scotstoun on the Clyde, an opportunity was offered to layout and construct one of the most up-to-date and best-equipped shipyards of its size in the world. Numerous natural advantages influenced the choice of Scotstoun as the site for the new yard, such as its excellent railway facilities, its economic possibilities as a labor market, its proximity to the iron and coal districts, the depth and width of the Clyde at this point, and the proximity of the Skelmorlie measured-mile trial course, which is now recognized as the only reliable mile on the British coast over which to test vessels of exceptionally high speeds.



PLAN OF THE YARROW SHIPYARD ON THE CLYDE.

The general arrangement of the works is shown in the plan, Fig. 1. It comprises an area approximately 820 feet by 700 feet, and includes engine and boiler shops, a blacksmith shop, a pattern makers and joiners' shop, the platers' shed, a covered-in fitting-out dock with adjacent sheds for pipe fitters, etc., together with eight building slips and the necessary store rooms, offices, etc. Electric power is used throughout the works, it being supplied by the Clyde Valley Power Company in the form of three-phase alternating current, twenty-five cycles per second at a high voltage, which is reduced to 400 volts by static transformers. As the firm wished to use a considerable number of continuous-current motors, which had been installed in their works at Poplar, an electric sub-station was installed at the plant, consisting of two motor generators, which can be run in parallel. Each machine is rated to give continuously 1,190 amperes at 210 volts. The alternating-current motors are each 365 horsepower at 485 revolutions per minute. Decided preference was also expressed for direct current on the ground that inverted arc lighting would give the best satisfaction for the general offices. It is expected that if additional power is required alternating-current motors will be installed as necessary. Electrically-driven pumps are provided to supply power to the various hydraulic tools. The pumps were furnished by the Leeds Engineering & Hydraulic Company, Ltd., Leeds, and the motors by the British Westinghouse Electric & Manufacturing Company, Ltd., Manchester.

Turning to the plan of the works, Fig. 1, it is seen that the general offices are located in the center of the north side, with the boiler shop to the east and the machine shop to the west. Mr. Yarrow's office is, as it were, the center of gravity of the whole yard, and consequently secures the minimum distance for him to go to see any member of his staff or for them to come to see him. The building berths and fitting-out basin are, of course, located at the water's edge, with the platers' shed immediately in front of the launching ways.

GENERAL VIEW OF THE NEW SCOTSTOUN WORKS OF MESSRS. YARROW & CO., LTD.

Between the platers' shed and the boiler shop is a space which is served by an overhead 7-ton crane of 85 feet span, by Messrs. Broadbent, of Huddersfield, traveling on a gantry, which is 330 feet long. This space is used for the construction of shallow draft steamers which are built by Messrs. Yarrow in sections for export. The boats are erected on shore at this place previous to shipment.

The facilities for handling material have been most carefully worked out, so as to provide for a minimum amount of handling and transporting. All of the shops are thoroughly equipped with overhead traveling cranes carefully designed for the loads which they have to lift, and the entire yard is served by a narrow-gage railway system, which is used largely for carrying material from the angle and plate racks to the platers' sheds and various machine tools. In the covered-in fitting-out basin material is handled by means of a 50-ton traveling crane, supplied by Messrs. Applebys, Ltd., Glasgow and Leicester.

The two most important shops in the yard are the boiler and machine shops. The boiler shop is the largest, being 300

THE MACHINE SHOP.

feet long by 153 feet wide. It is divided into three bays, one 50½ feet wide, served by one 20-ton and one 10-ton crane at a height of 40 feet 6 inches above the floor level. The center or erecting bay is 65 feet 4¼ inches wide, served by one 50-ton and one 10-ton crane at the same level as in the north bay. The south bay is 36 feet 4 inches wide, and is served with one 5-ton crane located 25 feet 6 inches above the floor level.

The machine shop is 210 feet long and 153 feet wide, and is also divided into three bays, one 37 feet 1 inch wide, served by a 5-ton traveler; a middle bay, 65 feet 1¼ inches wide, with a 5-ton crane at a height of 30 feet above the floor level; a 50-ton crane at 41 feet 8 inches above the floor level, and a south bay, 50 feet ⅜ inch wide, served by a 20-ton and 5-ton crane located 30 feet 6⅜ inches above the floor level.

The design of these shops, which was carried out by Sir William Arrol & Company, Ltd., is an excellent example of modern engineering workshop construction. The buildings are of the self-supporting steel frame type, with 9-inch brickwork built into the frame work to form the outer walls. The roofs of the boiler and machine shops are of the cantilever type, supported by internal cross girders at the ridges, which in turn are rigidly secured to the gantry columns placed 30 feet apart, the whole being covered with ¼-inch glazing. On account of the glazed roofs, light painted steel work and white-washed walls, the shops present an exceptionally pleasing appearance, and are far more comfortable for the workmen than the old type of dark, grimy building.

The platers' shed is 180 feet long by 90 feet wide and 18 feet 6 inches high. In it are located the furnaces and machine tools used in connection with the hull construction. No very large tools are installed, as most of the vessels built by Messrs. Yarrow & Company are of medium size, such as torpedo boat destroyers, shallow draft river boats, fast launches, etc. The machine tools include plate punches, shears, plate bending rolls, joggling rolls, large emery grinders and drilling machines. These are all motor-driven. Among the somewhat unusual tools are a high-speed saw for cutting rolled sections cold, which was supplied by Joseph T. Ryerson & Son, Chicago, and a Britton plate-stretching machine for pulling thin plates in order to take the buckles out. This work was formerly done by hammering, which is usually a long and laborious process. Most of the plates are drilled by compressed air by means of ordinary pneumatic drills, suitable arrangements being made for carrying out this work economically and expeditiously.

The equipment of the boiler shop includes some special tools for building the well-known type of Yarrow watertube boiler. Furnaces are provided, of suitable size, to heat the plates which form the steam and mud-drums of the boilers, as these are all bent hot. The tube plates of these boilers have to be thick in order to compensate for the amount of metal cut away in drilling, and the sides of the tube plates are reduced so as to correspond with the thickness of the wrapper plates. This work is done in a Hugh Smith planing machine, which has a maximum stroke of 28 feet. This machine also planes the plate edges and reduces the tube plates to the required thickness in the way of butt straps, and it can also plane the sides of the water-pocket tube plates and steam-drum tube plates. A special Buckton planing machine is also provided for planing tube plates for steam drums and water pockets after they are pressed to shape. The stroke of this machine is 18 feet, and it takes a width of 5 feet 6 inches and

THE FITTING-OUT DOCK.

a height of 6 feet. The steam drum tube plates are bored and turned in a special boring machine, supplied by Messrs. F. Berry & Sons. A special vertical boring mill for machining steam drum ends and water-pocket ends was also supplied by the same firm. The holes in the tube plates are all drilled through jigs. There are four multiple-spindle drilling machines, supplied by Messrs. Joshua Buckton & Company, and an oval hole-cutting machine for manholes, furnished by Messrs. G. & A. Harvey. The riveting plant consists of one 13-foot gap machine and an 18-foot gap machine of Messrs. Henry Berry & Company's make. Pressures of 20, 40 and 60 tons on the rivet can be secured with both of these machines.

In the machine shop are many tools from English, American and Continental builders. These include Buckton planing machines, Asquith radial drills and lathes by Lang, Harvey, Muir, Hulse and Archdale. There are lighter automatic machines by Messrs. Pratt & Whitney. Prominent among the American machines are noted Niles Tool Company lathes, Pond radial drilling machines, Brown & Sharpe milling machines, Sellars tool grinders and the Diamond Machine Company's emery grinders. Among the tools supplied by Continental firms are a surfacing lathe from the Oerlikon Company.

Mention has already been made of the covered-in fitting-out basin, which is supplied with a 50-ton traveler overhead. The total length of the runway is 323 feet and the crane is 56 feet above high-water mark. The roof for the basin is 275 feet long, of the cantilever type, completely glazed. The basin is dredged to a depth of about 14 feet at low water, so that the vessels will float at all stages of the tide. The depth of water in the river in front of the launching ways is 23 feet at low water, and the width of the river is about 500 feet, so that there is ample room for launching purposes. On either side of the covered-in basin are wharves covered by lean-to roofs, under which are located plumbers and pipe fitters' shops.

For the special class of work of which Messrs. Yarrow have made a specialty the layout of the works is such that beyond a doubt it should secure for the firm the very lowest cost of production.

THE MARINE STEAM ENGINE INDICATOR—XIX.*

BY LIEUT. CHARLES S. ROOT, U. S. R. C. S.

THE EXHAUST LINE.

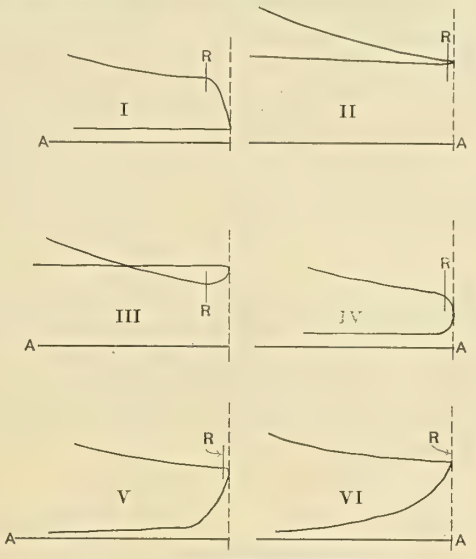
In order that the piston may begin its return stroke without unnecessary resistance, it is desirable that the pressure of the working steam be reduced to that of the condenser, receiver, or exhaust pipe by the time the crank pin crosses the dead center. To accomplish this result it is necessary in most cases to open the exhaust before the dead center position is reached, the exact point depending on the rotative speed, ratio of expansion, type of valve gear and other conditions.

The line *DE* of Fig. 95[1] is the *exhaust line,* and shows an ideal set of conditions for an engine turning at slow rotative speed. Diagram I of Fig. 104, is a close approach to the exhaust line of Fig. 95. This diagram was taken from the high-pressure cylinder of a compound pumping engine, and shows nearly a maximum card area at the "toe" with a minimum back pressure at the beginning of the return stroke.

Diagram II shows an exhaust line from the high-pressure cylinder of a triple-expansion pumping engine. This is also ideal. The expansion line is carried almost to the counter-pressure, and the exhaust opens at the proper time to realize minimum back pressure at the beginning of the stroke.

With engines turning at moderate rotative speeds engineers have found it expedient to close the exhaust before the end of the stroke, in order that a steam cushion may form and thus bring the reciprocating parts gently to rest and do away with shock on the bearings and other connections at the time the motion of the piston reverses. While it is well to keep the card area as large as possible, with any given point of cut-off, it is useless to delay release or exhaust opening until the end of the stroke when compression is used to form a cushion and for the following reasons:

In studying indicator diagrams one is very apt to form the habit of thinking of the steam events on one side of the piston



A=Atmospheric Line
R=Point of release

FIG. 104.

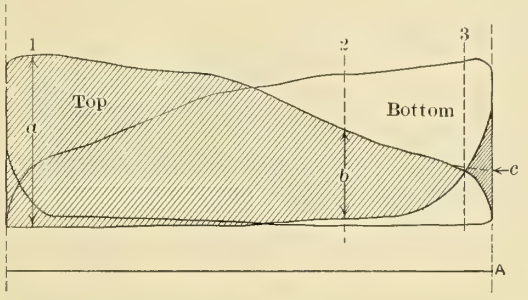


FIG. 105.

only, as this is all that is necessary to consider in ordinary diagram analysis. But when we come to figure on actual piston loads and their effect on the connections and bearings the pressures on both sides of the piston must be kept in view.

A little thought will make clear the fact that the actual load on the piston at any point is the difference between the *forward* or steam pressure and the *back* or exhaust pressure. Thus in Fig. 105—considering the down stroke only—the forward pressure at 1 is equal to the length of the ordinate *a* between the steam line of the top card and the exhaust line of the bottom card. At 2 it is equal to *b;* at 3 the forward and back pressures are equal, and the load on the piston is zero.

For every piston position to the right of ordinate 3 the back pressure exceeds the forward pressure, the effect being to resist the movement of the piston and bring the reciprocating parts to rest without shock. The magnitude of this opposing pressure is measured as described for the forward pressure. To make the diagram clearer the area representing the forward pressure is filled in with widely spaced hatching and the counter-pressure area with fine hatching.

The reason for not delaying release until the end of the stroke will now be clear.

In the diagram Fig. 105, if release had been so delayed the

* Copyright, 1911, by Charles S. Root.
[1] September, 1910, issue.

expansion line would have continued to *c*, and the greater part of the counter pressure caused by compression would have disappeared.

Further, if the exhaust is opened before the end of the stroke it helps towards a good exhaust opening at the beginning and middle of the return stroke, as will be shown when we come to consider valve setting. If expansion is carried too far by reason of a very early cut-off a loop will be formed, as shown in Diagram III. of Fig. 104. This is a bad condition. The loop creates a counter pressure in addition to that caused by compression, and what is worse it reduces the temperature of the cylinder below the average exhaust temperature.* If the valve is late in opening—on a slide-valve engine—the exhaust is cramped and diagrams like IV., V. and VI. will result. Another condition which will cause a bad exhaust line is wet steam. Steam in a wet state is less easily expelled than when dry, and is one of the indirect causes of the great loss of efficiency due to the presence of water in suspension in the steam.

* On some voyages it is necessary to run slowly for several hours in order that a "land fall" will be made during the hours of daylight. In such cases the engineer who wishes to keep his coal consumption down will reduce the revolutions by an early cut-off in the high-pressure engine, using the cut-off screw in the rock-shaft arm. If this is not enough, the rock shaft itself is partially rotated with the reversing engine, linking or "notching up" all of the engines at once. If this procedure causes loops in the diagrams, the cut-offs are too short. The links should be run out just enough to avoid the loops and the throttle used to regulate the revolutions.

(To be Continued.)

PLANT OF THE NEWPORT NEWS SHIPBUILDING AND DRY-DOCK COMPANY.

The plant of the Newport News Shipbuilding & Dry-Dock Company, which is located at Newport News, Va., on Hampton Roads, has, by virtue of its location, many advantages which are not possessed by other large shipyards. The yard represents an investment of $15,000,000 (£3,080,000), covers nearly one hundred and twenty acres, and has a water frontage of half a mile. The arrangement of the yard is the result of a most carefully perfected plan to have all the work on a ship from its design to its completion absolutely progressive. The material enters at one place, and, as it is handled, moves steadily forward to its final destination without, in any case, retracing its steps.

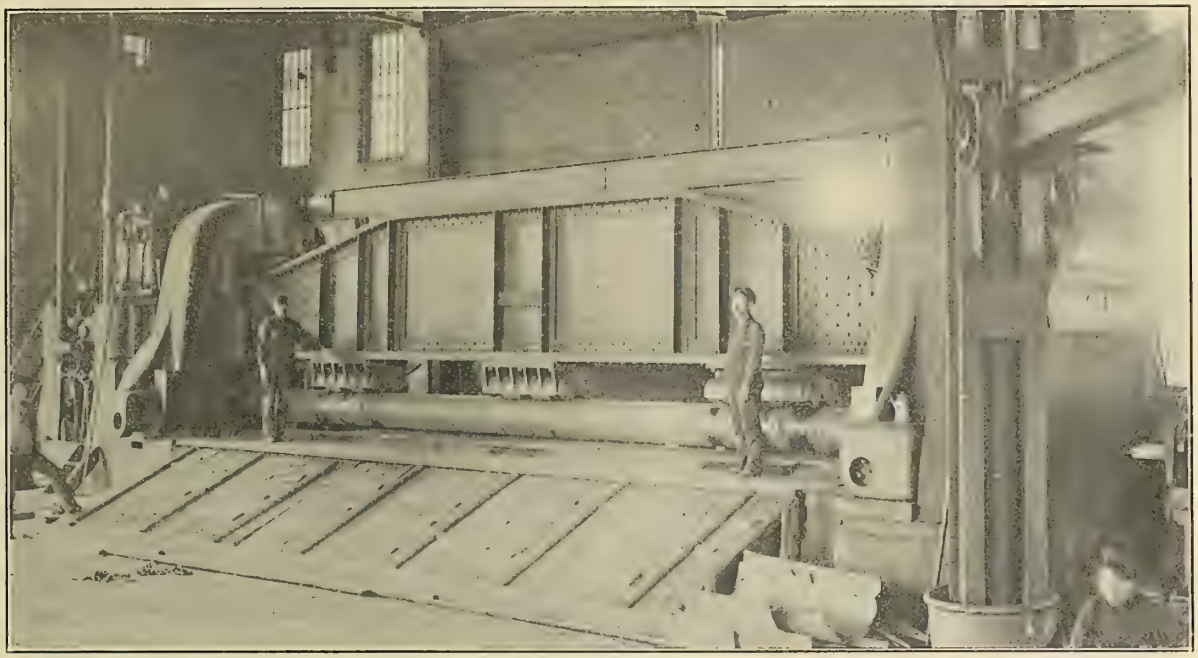
The buildings, most of which are brick structures, cover about twelve acres. The shops are so grouped as to permit the advancement of the work. They are connected by railroad tracks, so that material which is handled by the company's locomotives may be expeditiously transferred from shop to shop or from shop to shed, etc. A double track connects the works with the main line of the Chesapeake & Ohio Railroad. There are about seven miles of standard gage railroad track, covering various portions of the shipyard.

150-TON REVOLVING CRANE.

A battery of eight large marine Scotch boilers, working at a pressure of 120 pounds per square inch, supplies steam for power purposes. There is an electric plant with a capacity of about 2,500 kilowatts and four air compressors capable of compressing a total of 9,000 feet of free air per minute to a pressure of about 100 pounds per square inch. There is also a hydraulic plant of large capacity for supplying power to the hydraulic tools. The entire shipyard, including shops, wharves and dry-docks, is lighted by electricity.

There are two departments in the yard—the hull department and the machinery department. These, in turn, are subdivided into smaller ones, each under the supervision of an experi-

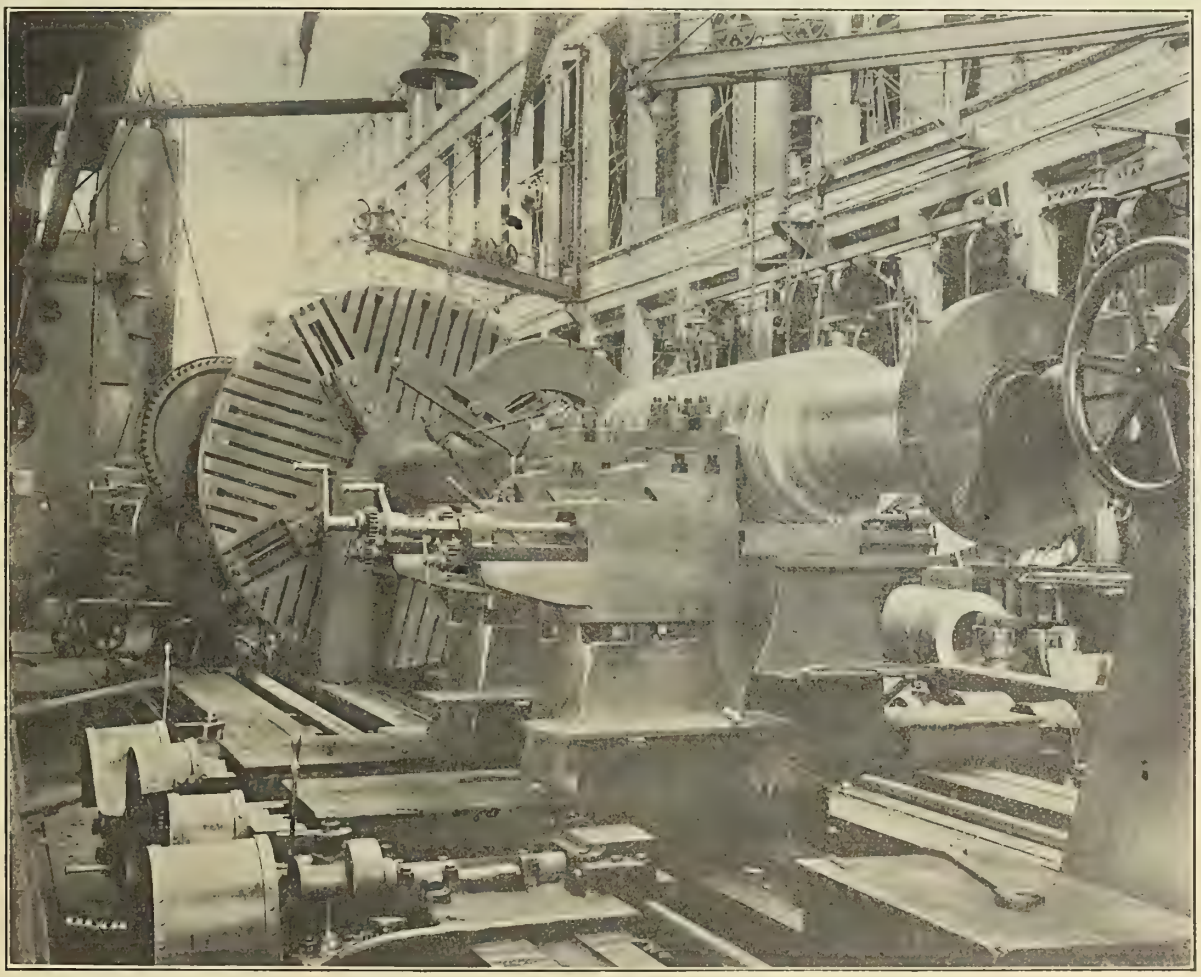
GENERAL VIEW OF THE NEWPORT NEWS SHIPYARD.



LARGE PLATE-BENDING ROLLS.

enced foreman. The departments are so arranged with relation to one another that the material may be transferred from one to the other by the shortest route. One group is formed by the ship shed, framing shed, etc.; another by the machine, boiler, blacksmith, copper and outfitting shops, and a third by the joiner and pattern shops, lumber sheds and sawmill. The piers and drydocks also have the necessary shops and tools located adjacent to them to facilitate the carrying on of repair work.

In the framing shed there is a large manhole punching machine, capable of punching a hole 27 inches by 18 inches through plates nearly an inch thick. All work in and about the



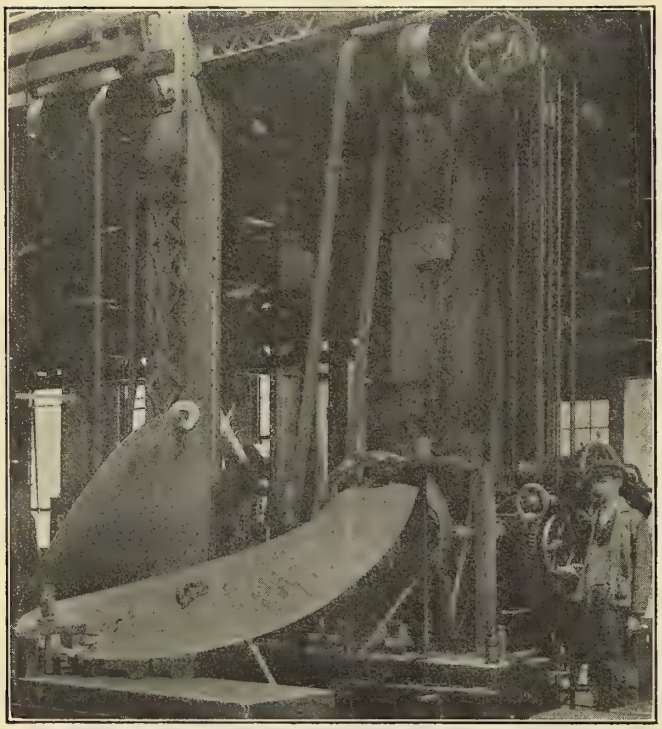
MACHINING A THRUST SHAFT.

framing shed is handled by electric cranes. In the ship shed, which is near the framing shed, there are 32-foot bending rolls, guillotine shears, shear blade grinders, cold saws, countersinking machines, a 32-foot planer, 16-foot bending rolls and numerous smaller tools. The second floor of the building is used as a mold loft.

Adjacent to the ship shed is the bending shed, containing furnaces where bars of iron 70 feet long can be heated for bending. The building berths, on which new vessels are laid down, are located near these shops, the berths being served by cantilever cranes. There are five of these cantilever cranes, three of which handle material for two ships simultaneously under construction on either side of its trestle. This company was the first in the world to utilize this type of crane for shipbuilding. With two exceptions, all of these cranes are operated by electricity. There are six locomotive cranes which also handle and transport material.

The machinery department includes one of the largest and best-equipped machine shops in America. The building is 100 by 560 feet and contains planers 36, 60, 84 and 120 inches in length; also an immense wall planer which requires a 50-horsepower motor for its operation. The heavy machine tools are located in the main part of the machine shop and in the galleries are the brass working machines. All material is handled by electric traveling cranes, the largest having a capacity of 50 tons.

The rigging loft, boiler, blacksmith, joiner, copper, ship carpenters and other shops are all fitted with modern up-to-

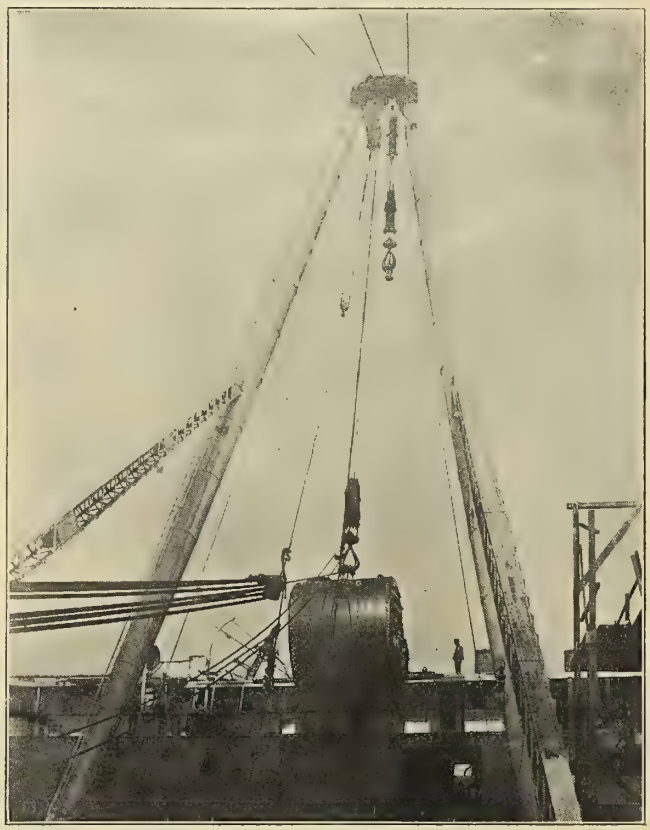


A CORNER IN THE MACHINE SHOP.

date machinery. In the blacksmith shop there are steam hammers, ranging from 600 to 6,000 pounds. Forced draft is employed for the forge fires.

Two important auxiliaries in the yard are a 150-ton electrically-operated revolving derrick and a set of shear legs of 100 tons capacity. The yard is well provided with dry docks, there being two about 593 and 537 feet extreme length, respectively, and one with an extreme length of 804 feet. The latter is built of timber with a masonry entrance, the masonry being constructed on a concrete foundation that rests on piles and timber superstructure. In connection with it is a pumping plant, comprising three main centrifugal pumps of 100,000 gallons capacity per minute each, and two drainage pumps with a capacity of 12,000 gallons per minute. The main pumps are driven by electric motors of 1,000 horsepower each at 500 volts. It requires about one hour and thirty minutes to pump out one of the smaller docks, and about two hours and fifteen minutes to empty the larger one.

On the water front there are seven large piers, one of which



100-TON SHEAR LEGS.

is 900 feet long; the fitting-out basin is 900 by 500 feet and has a depth of water of about 40 feet.

In addition to the shops in the yard, the company operates a large foundry for steel and iron castings and for brass work. The foundry is connected with the main works by the company's railroad, and is but a short distance from the main works. All the machinery in the foundry is operated by electric motors supplied from the main power house at the shipyard.

THE SHIPBUILDING AND ENGINEERING WORKS OF MESSRS. GIO. ANSALDO-ARMSTRONG & COMPANY.

In 1853, when the Kingdom of Sardinia was undergoing an economic transformation, the small compartment of Piedmont was brought into prominence by new railway facilities and immediately entered upon a new industrial era. Mr. Carreur, then Prime Minister, saw the necessity of an adequate mechanical establishment which would be able to carry out the large projects then under way, and, utilizing a modest contract shop, established at Sampierdarena, near Genoa, since 1846, he formed the Gio. Ansaldo Company, entrusting the management to Mr. Ansaldo, who was at that time a prominent professor of mechanical engineering.

The shops of the new company were at the time the best equipped in Italy, and, as early as 1854, they supplied the first

two locomotives for the Piedmont railways. In connection with locomotive building, Messrs. Ansaldo made a specialty of the construction of other materials for railway use, and also of marine engines and boilers and marine repairs. In 1867 these works undertook the construction of the large engines for the Italian iron clad *Palestro,* and subsequently also the engines for the two ships *Staffeta* and *Mariantonio Colonna.* The reputation of the firm for marine work was enhanced by turning out the stem and stern post forgings of what were then the largest battleships, the *Duilio,* the *Dandolo,* *Italia* and *Seepanto.* In 1870 the works were increased by the addition of a small shipyard where the royal naval vessel *Staffeta,* the lake steamer *Venbano* (which is still in service) and the freight steamer *San Gottardo,* together with a large number of smaller ships, were built.

In 1883 the concern passed into the hands of the Bombrini Bros., and a new impulse was given to the industry. In 1866, in order to provide more room for the engine works, it was found necessary to transfer the yard to Sestri Ponente, which is two miles from Sampierdarena. Again, in 1886, it was found necessary not only to enlarge the shops but also to have new ones erected, and to establish a foundry for brass and special metal work at Coruigliano. Here also was established a steel foundry and a large shop for building special naval electrical machinery. At the same time there was erected in the harbor of Genoa, as an adjunct to the shipyard, a large shop for the completion and equipment of vessels after their launch, and, finally, on account of a contract for refitting and repairing some vessels of the Turkish navy, the Messrs. Ansaldo established a shop, with an Italian staff of

DRYDOCK AT NEWPORT NEWS.

WAITING FOR REPAIRS AT THE ANSALDO YARD.

workmen, in the Imperial shipyards at Constantinople. In 1903 the business passed from the control of the former owners into the hands of Messrs. Gio. Ansaldo-Armstrong & Company; the late Commodore Ferdinando Maria Perrone was then general manager of the company, and it was largely due to his efforts that the Italian naval industry was brought to its present state of imporance. At present the firm employs about 5,000 workmen.

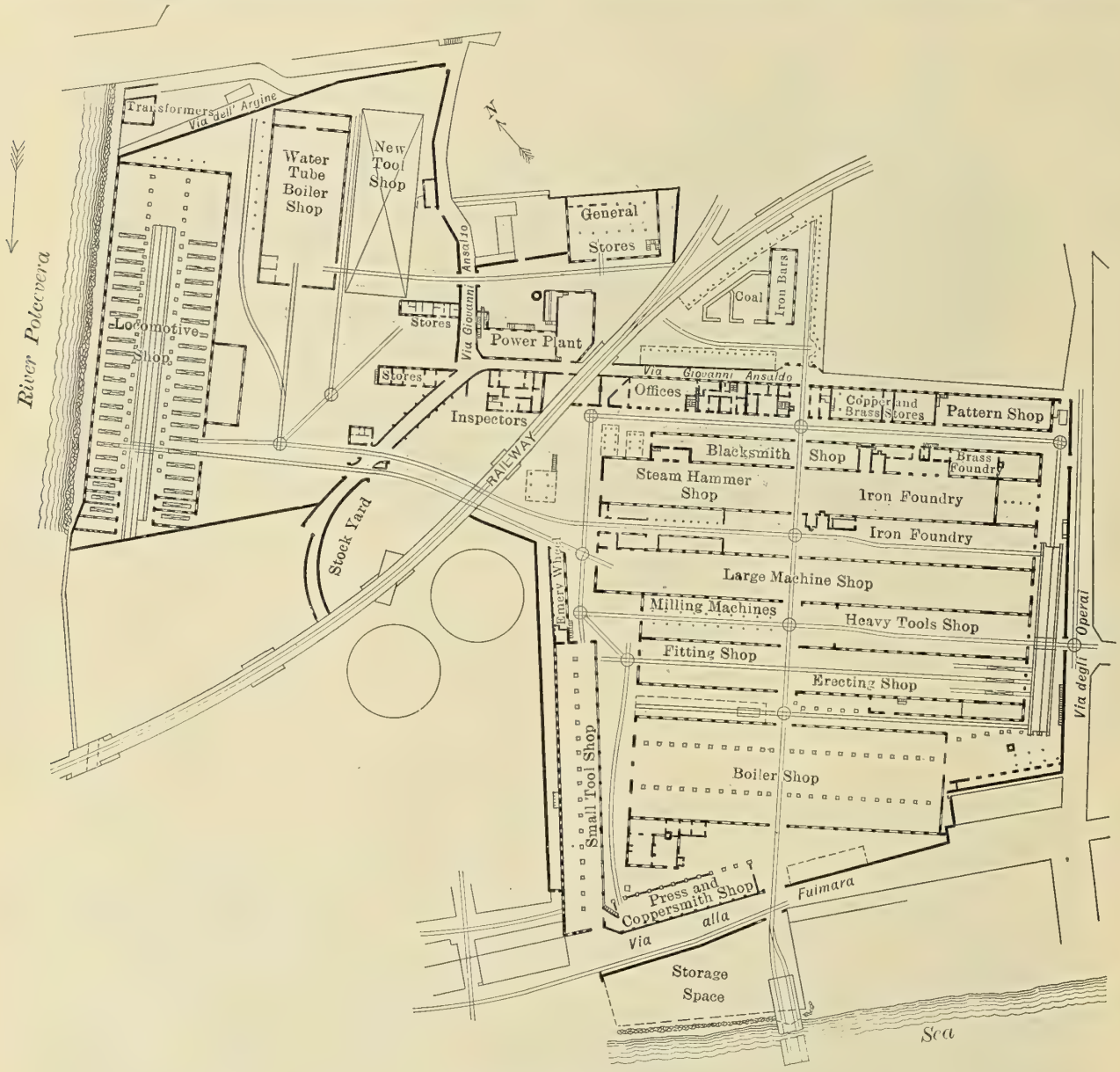
THE WORKS AT SAMPIERDARENA.

The numerous shops which comprise these works occupy at present a covered area of about 12 acres and an open space of about 8 acres. They include a pattern shop, foundry (iron and brass), large turning and machine shop, lathes, boring and milling machine shop, small tool shop, brass machine shop, boiler shop, fitting shop, emery wheel shop, locomotive erecting shop, large erecting shop, laboratory, hydraulic press and coppersmith shop, watertube boiler and sheet iron shop, and, finally, the blacksmith and steam hammer shop.

All of the shops are furnished with electric power at 220 volts. Electricity is also used for lighting, current being provided at 120 volts. Electric drills and pneumatic tools are used extensively. All of the large machine tools in the different departments are driven by individual electric motors, and the smaller tools are arranged in groups connected to electrically-driven shafting. A power station is located within the works, but in the immediate future power is to be supplied by a private company situated 50 miles from Sampierdarena. Alternating current at 66,000 volts will be transmitted from this station to the works, where it will be transformed to a lower voltage to drive a motor generator designed to supply direct current at 220 volts.

Railway connections are provided between the works and the sea, so that large boilers, castings, forgings, etc., can be lifted and carried directly to the harbor of Genoa, or to the shipyard at Sestri Ponente, or shipped directly on board the vessels by means of a 120-ton floating pontoon.

The equipment of the works includes about a thousand machine tools of every description, ranging from the heaviest steam hammers to the most delicate laboratory apparatus. Most of the company's machine work and casting is done at this plant, the principal production consisting of locomotives, boilers of all kinds and the propelling and auxiliary machinery for both naval and mercantile vessels. At present there is



PLAN OF THE ANSALDO YARD.

PANORAMIC VIEW OF THE SHIPYARD AT SESTRI PONENTE.

under construction the propelling machinery for the battleships *Giulio Cesare, Leonardo da Vinci* and *Contedi Cavour.* Each of these plants consists of 24,000 shaft horsepower of Parsons turbines. There is also nearing completion turbines for the *Quarto* of 25,000 shaft horsepower, the 12,500 indicated horsepower reciprocating engines of a new twin-screw Turkish cruiser, the 1,150 indicated horsepower reciprocating engines of the twin-screw tank steamer *Eridano;* the 1,850 indicated horespower reciprocating engines of the twin-screw tug *Titano,* also reciprocating engines for twelve torpedo boats of 2,700 indicated horsepower each, one set of Parsons turbines for a 2,700 shaft horsepower torpedo boat, the machinery for which is to be arranged on three shafts, and one set of Bergmann turbines for a 2,700 shaft horsepower torpedo boat, all of which are being built for the Italian Government. Further, there are two sets of reciprocating engines of 6,000 indicated horsepower for a Chinese destroyer. The firm also

HEAVY TOOL SHOP.

has a contract for seventy-two locomotives, to be finished before June.

The foundry for steel castings at Coruigliano supplies all the requirements of the main works at Sampierdarena for the locomotives, turbines, marine engines, etc. Recently an addition has been made to this plant to accommodate another 25-ton gas furnace installation. The electric shop at Coruigliano occupies a ground area of about 2¼ acres and makes a specialty of electric gear for use on board ships, such as hoisting appliances, winches, windlasses, etc.

THE SHIPYARD AT SESTRI PONENTE.

This yard occupies an area of about 25 acres and has a water frontage of 1,650 feet. There are five building berths, capable of accommodating the largest vessels which are built at the present time. Three other wooden slips are used for the construction of medium-sized vessels. For smaller boats, such as torpedo boats, destroyers, etc., covered berths are provided. The entire plant is thoroughly equipped with modern machine tools electrically operated. Alongside the building berths are located all of the shipbuilding tools, such as punches, shears, drills, countersinking machines, beam

IN THE FITTING SHOP.

PORTION OF TURNING AND MACHINE SHOP.

benders, plate-bending rolls, etc. The mold loft covers an area of about 15,000 square feet.

A notable example of the class of work turned out at this yard is the *Garibaldi* type of cruiser, which was duplicated five times by this company for foreign nations. One of these vessels was the *Cristobal Colon,* of Spanish-American War fame. As an indication of the speed with which work is turned out, the armored cruiser *Kasuga* was laid down March 14, 1902, and launched October 22 of the same year. Her sister-ship, the *Nisshin,* was also built in the same rapid time. When these two cruisers were sold to Japan they made the voyage from Genoa to Yokosuka, with an inexperienced crew, at a higher rate of speed than has ever been maintained by any other armored vessel in so long a voyage. Upon their arrival in Japan the boilers, engines and all parts of the ship were found to be in good condition, so that they immediately went into service in Admiral Togo's squadron.

There is now under construction in this yard the battleship *Giulio Cesare,* 21,500 tons, 24,000 shaft horsepower and 22.5 knots speed; one Turkish cruiser of 12,500 indicated horsepower; one tank steamer of 11,000 indicated horsepower; one tug boat of 1,850 indicated horsepower; eight torpedo boats for the Italian Government and one Chinese destroyer of 6,000 indicated horsepower. For the construction of the battleship *Giulio Cesare* one set of electric cranes was installed on each side of the building berth.

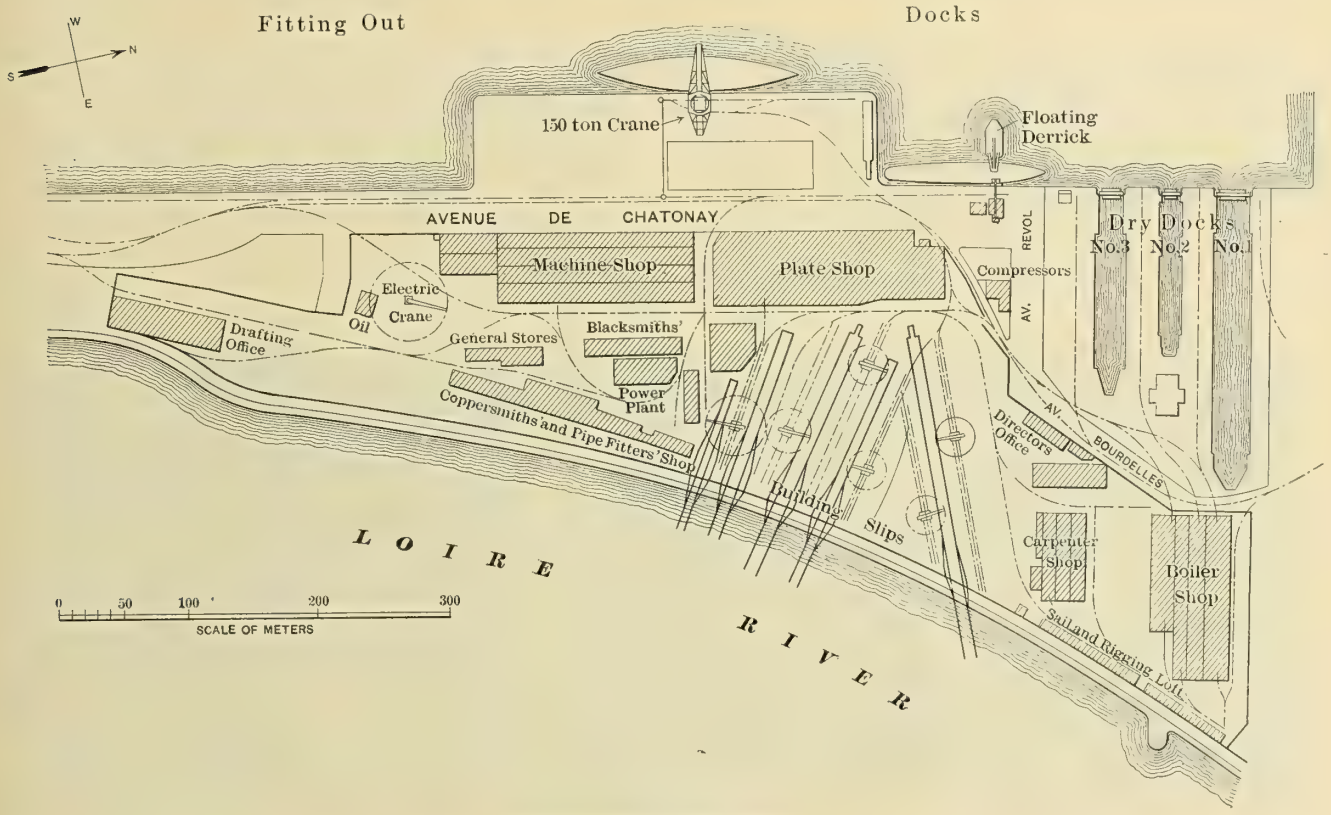
THE FITTING-OUT SHOPS IN THE HARBOR OF GENOA.

This shop serves as a complement to the works at Sestri Ponente; for although, if necessary, merchant ships can be launched complete at the latter place, with their engines and boilers installed ready for service, nevertheless naval vessels, especially large cruisers and battleships, require a large amount of work after launching, such as the fitting of armor plates, turrets, guns and various auxiliaries. This shop has been installed for the purpose of doing such work. The shops occupy a total area of about two acres, four-fifths of which are covered in. It is completely equipped with modern tools for the special work which is required. A part of the equipment includes tug boats, floating pontoons and berths for lifting and shifting heavy weights, and also a powerful dredge for harbor excavation.

FORGES AND CHAUTIERS DE LA MEDITERRANÉE.

This yard was established in 1857 at La Seyne, near Toulon. It includes a shipbuilding yard at La Seyne and engine shops at Marseilles. There are also other slips and engine works at Havre, but they are less important. Both yards are equipped with facilities for building any type of vessel and large numbers of vessels for both mercantile and naval work have been constructed not only for French owners but also for foreign navies, including Brazil, Chili, Greece, Japan and Russia. Prominent among these may be mentioned the *Czarewitch,* of 12,932 tons, which, at the time of her construction, was a very noteworthy battleship, largely on account of the new features embodied in her design, which were a distinct advance over anything then in use in other navies. The principal feature was the anti-torpedo protection, which is similar to that which is to-day found in battleships of the *Danton* class, the German *Dreadnoughts,* and the new Argentine battleships building in America.

The main establishment of this company at La Seyne has a frontage of 3,900 feet on the Toulon roads. At the center of the yard is a fitting-out dock, 443 feet long and 115 feet wide, with sufficient depth to accommodate the usual type of vessel built. The main offices are in a large building facing the fitting-out dock, where ample room has been reserved for the drafting staff, which consists of about 150 men. There are seven building slips, two of which have an available length



PLAN OF THE ATLANTIC WORKS.

of 657 feet. They are built of masonry, and material is hoisted on to the slips by powerful pivoted electric cranes.

PLATE AND ANGLE SHOPS.

This department includes a large plate shop, 443 feet long, with two parallel bays, each 99 feet wide. The shop is served by eight overhead traveling cranes which operate at a speed of 262 feet per minute. One bay is designed for laying out plates and the other for fitting-up purposes. Close by is the plate yard, which is served by a high-speed traveling crane, so that material is handled quickly and cheaply. Above the plate shop is the mold loft, which is unusually large, being 443 feet long and 99 feet wide. The machines installed in this shop include, besides the punching and shearing machines, radial drills, planers, metal saws, etc.; five large planing machines, three hydraulic presses, a large manhole punch, all of which are electrically-driven and arranged so as to facilitate the progress of work through the shop.

Near this shop is the angle iron shop and small blacksmith shop. The equipment includes three large angle iron furnaces capable of taking bars 72 feet long. There are also four large hydraulic presses for bending beams and several metal saws, including one circular saw capable of cutting bevels.

CARPENTER SHOPS.

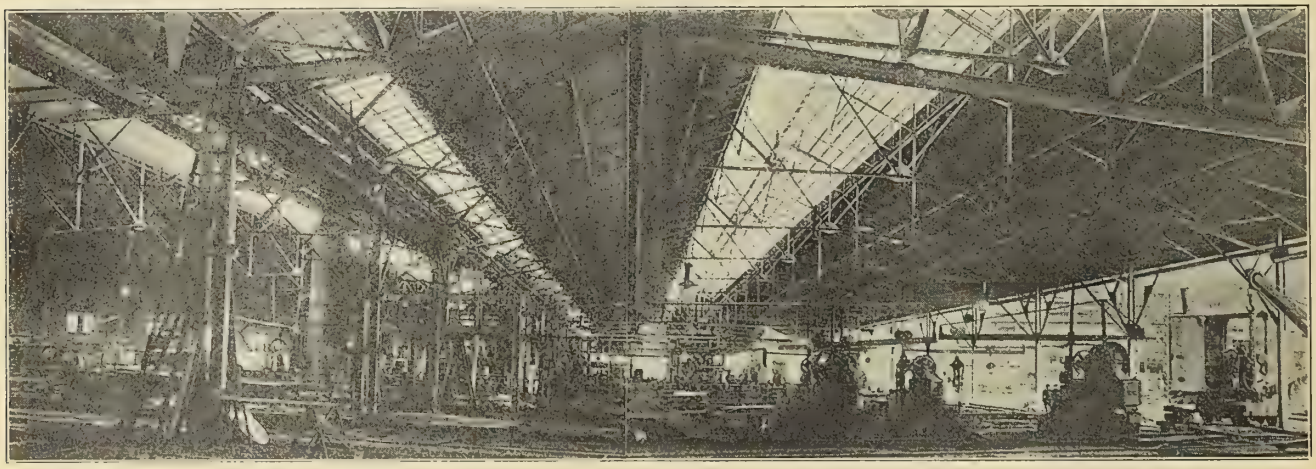
The woodworking department, which includes a covered area of 4,000 square feet, is situated at a distance from the other shops in order to minimize the danger from fire. The plant includes a carpenter shop, sawmill, joiner shop, model shop and lumber shed. The woodyard, which is 525 feet long, is served by an electrically-operated overhead crane, 85 feet wide, with a working speed of 262 feet per minute.

In the sawmill are six band saws and the usual equipment of woodworking tools.

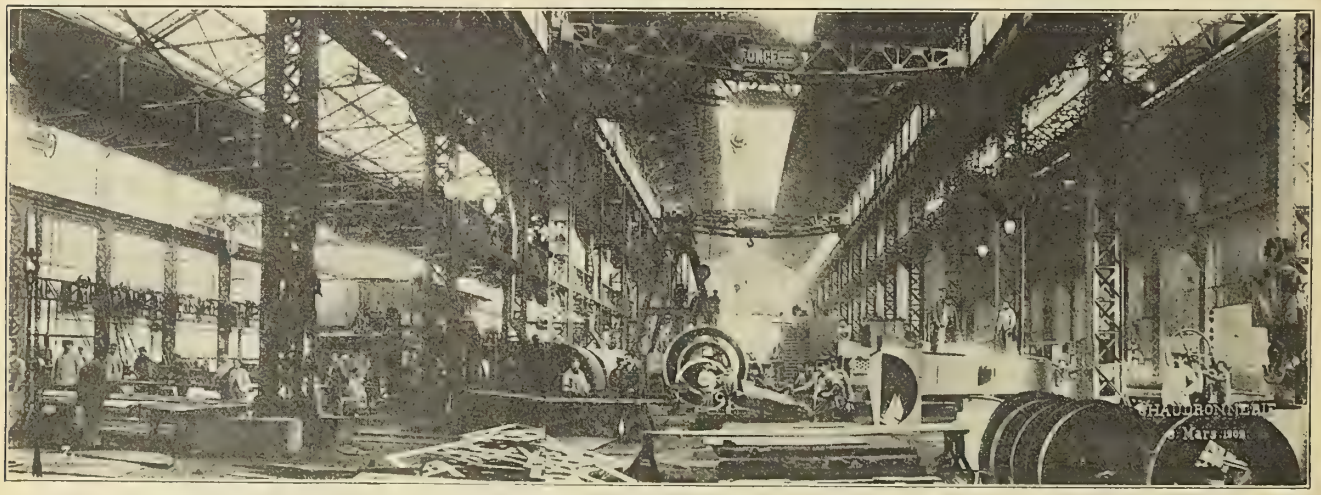
GUN AND ARMOR SHOPS.

This department includes the forge, fitting-out, electrical, locksmith, coppersmith, tool and galvanizing shops. The total area of this group is 8,900 square feet. The forge shop has a length of 290 feet and a width of 82 feet. It contains seven steam hammers, one of 4 tons, one of 2 tons, three of 1 ton and two ½-ton machines. There are also two heating furnaces and seventy small forges.

The fitting-out shop is divided into three bays, each 295 feet long, one 82 feet wide and the other two 40 feet wide. These are served by three electric overhead cranes, the largest of which has a lifting capacity of 35 tons. The first bay is devoted to small machine work and gear work, and its equipment includes about ninety machine tools, such as turning lathes, boring, countersinking, tapping and planing machines, etc. The principal lathes have been especially designed for handling large pieces of machinery and are capable of dealing



SHIP SHED, NORMANDY YARD.



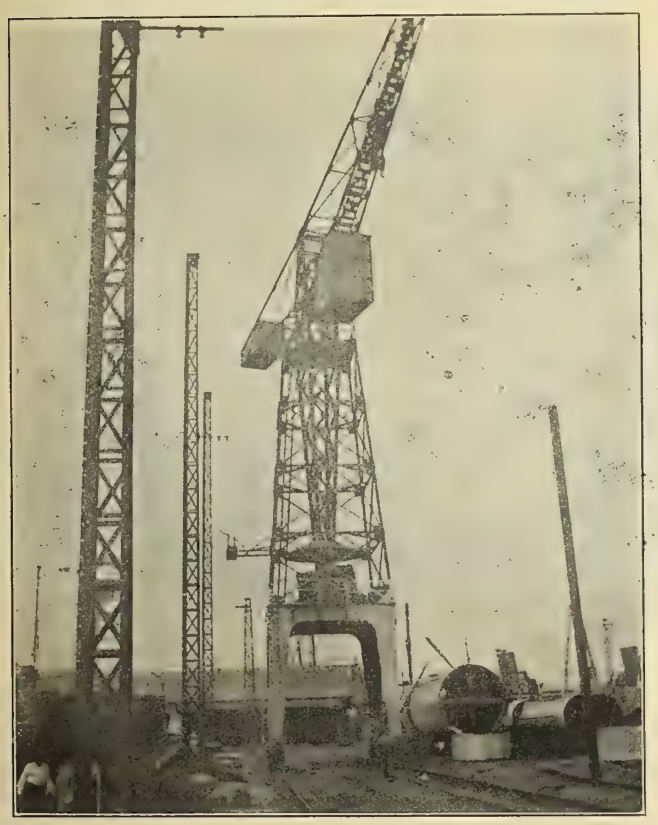
THE BOILER SHOP.

with pieces 39 feet 4 inches long by 23 feet diameter. The other two bays are intended for the fitting out and erection of engines.

TURBINE DEPARTMENT.

When it was decided that the battleships of the 1900 programme should be driven by Parsons turbines, this company obtained the rights for building this type of machinery, and a special shop was erected for doing the work. The shop is 363 feet long, 148 feet wide and is divided into two bays, each 74 feet wide, having an available height of 55 feet 2 inches. One bay is devoted entirely to the building of the principal parts of the turbines and rotors and is served by three overhead traveling cranes, one of 30 tons capacity and the other two of 10 tons each. The second bay is used for fitting up the turbines and is served by two overhead cranes, each of which has a capacity for lifting 60 tons. These cranes may be connected to deal with weights heavier than that.

After the turbines are ready for shipment they are loaded on a special car of 130 tons carrying capacity, on which they

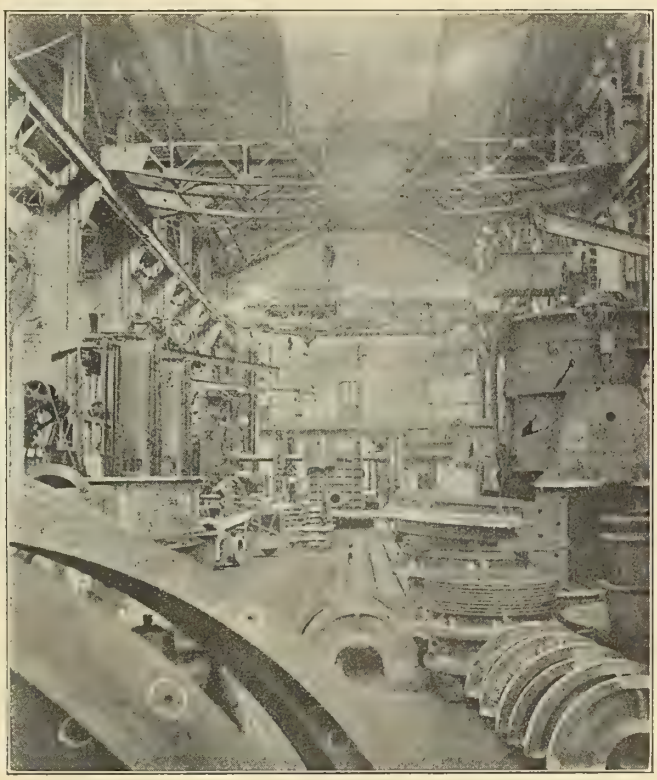


SLIP TOWER CRANE. ATLANTIC WORKS.

are carried to the fitting-out dock, where they are installed by a 150-ton floating crane. The tools in the turbine shop include a horizontal lathe weighing 180 tons, driven by a 60-horsepower electric motor, which is capable of dealing with pieces 56 feet 2 inches long and 16 feet 5 inches diameter. There is also another horizontal lathe weighing 180 tons, which can handle pieces 48 feet long and 11 feet 10 inches diameter. It is driven by a 60-horsepower motor. Another horizontal lathe, weighing 120 tons, can handle work 46 feet by 6 feet 2 inches. The latter is driven by a 40-horsepower motor. A vertical lathe, weighing 250 tons, is installed, which deals with work 22 feet 6 inches diameter and 26 feet 4 inches high. This machine is operated by a 60-horsepower motor, and it may also be used as a boring machine. There is a vertical lathe driven by a 25-horsepower motor for cylinders 13 feet 10 inches diameter and 5 feet 7 inches high. All of the above-named machines use high-speed steel tools exclusively, and special furnaces have been installed for dealing with these tools.

BOILER SHOP.

The boiler shop has been so arranged as to meet the requirements demanded in the construction of modern marine cylindrical boilers. It is 394 feet long, 140 feet wide, divided into three bays. The center bay, 66 feet wide, is served by two overhead electrically-driven cranes, which have a clear runway from one end of the shop to the other. One of these cranes has a lifting power of 100 tons and the other 25 tons. The two wing bays are served by the same number of cranes, but these cranes have a lifting power of only 10 tons each. This shop has a capacity of 2,000 tons of boilers per year. The machine tools include special equipment for the building of watertube boilers. There are four plate-bending rolls, eleven punches and shears, two beveling machines, two triple boiler shell drills, two radial drills, four hydraulic presses, two hydraulic riveting machines, one of 130 tons power, which is served by a hydraulic crane of 35 tons lifting power. There



TURBINE SHOP. ATLANTIC WORKS.

are also two portable riveting machines, four steam hammers, etc.

This plant was the first one in France to install portable pneumatic tools, and at present there are no less than 150 pneumatic drills, riveting, chipping and calking hammers, requiring in all 400 horsepower, in daily use. The equipment of the yard also includes four floating cranes of 15, 45, 80 and 150 tons lifting power respectively. The material is handled throughout the yard by steam-traveling cranes operating on railroad tracks. Part of the power for the shops is supplied the company's own power stations by turbo generators and part by an outside company.

The annual meeting of the Institute of Naval Architects will be held on Wednesday, April 5, and continue through the two following days in the hall of the Royal Society of Arts, John street, Adelphi, London, W. C.

St. Nazaire Shipbuilding and Engineering Company, Ltd.

The yard has a frontage of 2,950 feet on the River Loire, and on the opposite side of the yard is the Penhouet Dock, so that the plant is exceptionally well situated for shipbuilding purposes. Railroad connection with the State and Orleans railway, together with the exceptional dock facilities, insures the cheapest and most expeditious means of receiving material and shipping finished work.

There are five building slips at the Atlantic yard, all of masonry construction, the largest of which is available for ships up to 700 feet in length, and the smallest for ships 394 feet in length. As the climate in this section is not very severe the building slips are not covered in, and ships are launched according to the cradle method. The slips are served on both sides by electrically-driven tower cranes of a noteworthy type. They are 105 feet high, with an acting radius of from 47 feet 7 inches to 72 feet. They are capable of lifting 4 tons at 72 feet and 8 tons at 26 feet. The lifting apparatus is driven by a 30-horsepower motor, and the movement of the cranes along the rails is accomplished by a 15-horsepower motor. The jib of the crane is actuated by a 5-horsepower motor. The cranes have a speed along the rails of 23 feet per second and are capable of lifting a weight of 8 tons at a speed of 29 feet per minute. These cranes permit very easy, rapid and cheap handling of materials. The slips are provided with electricity and compressed air and hydraulic plants to facilitate riveting, drilling, etc.

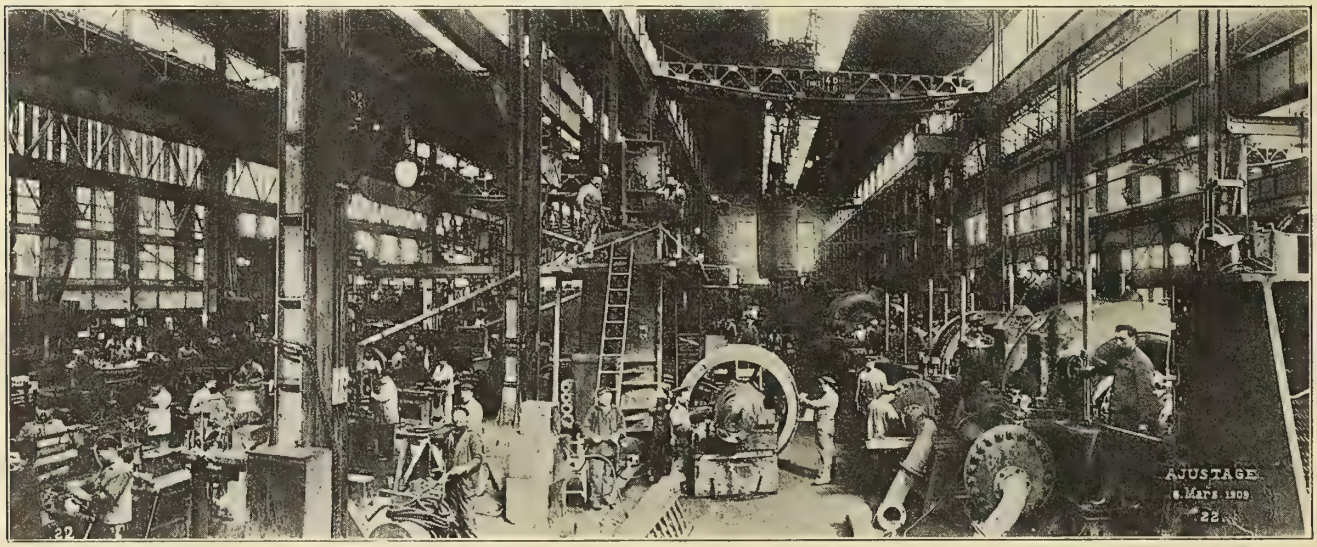
PLATE AND ANGLE SHOPS

These shops occupy an area of 115,000 square feet. The main shop is in front of the slips and is 578 feet long and 180 feet wide, divided into three bays, which are served by overhead traveling cranes. Hydraulic cranes serve the thirty principal machine tools, which have been arranged in such order as to avoid loss of time and confusion in handling materials. The shop contains three planing machines for plates 10 feet wide and 1 inch thick, hydraulic punching machines of 250 tons capacity, one garboard machine dealing with plates up to 1 inch thick and three rolling machines for 5/16-inch material.

The angle iron shop contains the angle iron heating furnaces as well as the furnaces where material is annealed after having been worked into shape. These furnaces are capable of taking bars up to 82 feet long, and large floor space with special machinery for doing the bending is provided. There are three bar-bending machines besides the necessary metal saws, etc. The annealing furnaces are large enough to accommodate the largest pieces which can be reheated without deformation. Special openings are provided in the furnaces to enable the workmen to note the appearance of the metal while it is being heated. When the pieces become cherry red the fire is extinguished and the pieces are left in the furnace without admitting cold air until they are cooled to normal temperature.

THE MACHINERY DEPARTMENT.

The engine department includes a forge shop, fitting-up shop, coppersmith shop and tool shop. The large forge shop is 197 feet long by 48 feet wide. In it are installed sixteen hammers, ranging from 500 pounds to 1,323 pounds. The coppersmith shop, including the galvanizing and pipe shop, is 263 feet long and 42 feet wide. A hydraulic press is used for bending pipes and a hydraulic accumulator is used for testing pipes and fittings. The fitting-out shop has an area of 85,000 square feet and is divided into four bays, served by six overhead cranes, which have a maximum lifting power of 50 tons. There are no less than 130 machine tools in this shop, the most important of which are the lathes, capable of dealing with work 52 feet 6 inches long and 13 feet 2 inches diameter. The part of the shop reserved for building and erecting turbines has an available height of 52 feet 6 inches; it is served by overhead traveling cranes, having lifting powers of 50, 30, 25 and 10 tons each. When it is necessary to lift a complete turbine these cranes are connected and a load of 100 tons is easily handled. The turbine part of the shop is the largest department. Among the modern tools installed there are a horizontal lathe, capable of handling work up to 2 feet 6 inches long; three horizontal boring machines dealing with 49 feet 3 inches; a vertical planing machine capable of handling work 23 feet long and 20 feet high; a horizontal boring machine with two sets of tools, etc.



THE ERECTING SHOP.

The part of this shop which is used for erecting purposes is 263 feet long, 66 feet wide and 49 feet 3 inches high. Here were erected the 30,000-horsepower engines of *La Provence,* as well as the 37,000-horsepower engines for the armored cruiser *Ernest Renan.* At the time of writing there are under construction the 40,000-horsepower Parsons turbines for the *France,* and until recently the 22,500-horsepower turbines for the battleships *Diderot, Condorcet* and *Mirabeau.*

CARPENTER SHOPS.

The carpenter and joiner shops are located at the opposite end of the yard, in order to remove as far as possible any liability of damage by fire. One building, 270 feet long and

109 feet wide, contains the carpenter shop, cabinet-making shop and the lumber store rooms. Among other tools are to be found a band saw for squaring timber and lugs and a four-side planing machine. An overhead crane is provided for handling material. In the joiner department there are thirty-one machine tools.

BOILER SHOP.

The boiler shop is located at the north end of the yard and is practically new, as it was only a few years ago that the shop was partially destroyed by fire. As it stands to-day, the building is 427 feet long and 210 feet wide, divided into four bays, served by eight overhead electrically-driven cranes operating at a height of 40 feet above the ground level. These cranes are capable of lifting weights from 10 to 70 tons at a speed of 16 feet 5 inches per second. The principal machine tools include two rolling machines, one of which is vertical, capable of dealing with plates 1⅝ inches thick and 11 feet 6 inches wide. Five punching and shearing machines for drilling boiler shells; two quadruple drilling machines for front end tube plates, nine rotary drills, three hydraulic presses for flanging plates, three hydraulic riveting machines, giving a maximum pressure on the dies of 160 tons; one portable hydraulic press and two steam hammers. Besides the necessary tools for building the ordinary type of Scotch marine boilers there are the necessary special tools for building watertube and locomotive boilers. The largest boilers made in this shop are those for the *France*, which are 21 feet 4 inches long and 17 feet 9 inches diameter, weighing 100 tons each.

EQUIPMENT DEPARTMENT

This department includes the sail and rigging loft, lifeboat shops, etc. The mold loft is at the south end of the yard and is 289 feet long and 72 feet wide. The pattern shop has an area of 1,500 square feet.

Power is delivered to the different shops from a central power station, where are installed three sets of dynamos actuated by steam turbines and reciprocating engines aggregating 20,000 indicated horsepower. The entire yard is lighted by electricity. The compressed air plant, which contains three air compressors, is situated just outside the yard. All heavy pieces, like turbines, turrets, boilers, etc., are loaded on special cars in the shops, and are then carried to the Penhouet dock quay, where they can be lifted off by a set of tower cranes. There are three of these cranes, one of which has a lifting power of from 150 to 180 tons, one of 80 tons and one of 30 tons. The large tower crane, which is electrically-driven, is 164 feet high above the level of the quay. It is capable of lifting a load of 150 tons at a speed of 3 feet 6 inches per minute, or a load of 60 tons at a speed 7 feet 7 inches per minute. The shear legs are 82 feet high and deal with loads up to 80 tons, while the other crane has a capacity of 30 tons.

Close by the yard, as is shown in the plan of the works, are three drydocks, one of which is 427 feet by 42 feet 8 inches by 13 feet 4 inches. The second is 551 feet by 59 feet by 24 feet, and the third is 738 feet long, 124 feet 10 inches wide and 30 feet draft. These docks are a valuable addition to the equipment, both on account of their capacity and their convenient location at the entrance to the yard, which insures that the maximum efficiency can be obtained at the cheapest cost.

THE NORMANDY YARD.

In this yard are six building slips, together with large shops containing electrically-driven machinery. The yard is connected with the Western and State railways, and on the river front there are provided wharves where large pieces of machinery, etc., can be loaded or unloaded by aid of large shear legs. Without going into the details of the equipment of this yard, it is sufficient to note that it is designed specially for the building of hulls of cargo and passenger boats up to 10,000 tons.

THE BRITISH BATTLE CRUISER LION.

The new British cruiser *Lion* is the most notable ship of war which has ever been built. She is no less than 700 feet long over all and 86 feet 6 inches in extreme beam, and her size may very well be compared with the *Lusitania*, which is 762 feet in length and 87 feet 8 inches in breadth. The displacement of the *Lion* at a mean draft of 27 feet 9 inches is 26,350 tons. She is of the all-big gun type of high-speed turbine cruiser, and in design marks a bold departure from the Invincibles of 1908, which were considered to be the last word in fast cruisers. The *Lion* will have a sea speed of 28 knots, which should be equal to a smooth-water speed of 30 knots. Her dimensions are given in the following table, in comparison with those of the *Invincible:*

	Lion.	*Invincible.*
Length, B. P.	660 feet 0 inches	530 feet 0 inches
Length over all	700 feet 0 inches	562 feet 0 inches
Breadth, extreme	86 feet 6 inches	78 feet 6 inches
Draft, mean	27 feet 9 inches	26 feet 6 inches
Displacement	26,350 tons	17,250 tons
I. H. P., designed	70,000	41,000
Speed, designed	28 knots	25 knots
Armor belt	9¾ inches	7 inches
Main battery	8—13.5-inch guns	8—12-inch guns
Secondary battery	24—4-inch guns	16—4-inch guns
Torpedo tubes	5—21-inch	5—18-inch
Coal capacity	3,500 tons	2,500 tons
Total cost	£1,950,000	£1,530,000

The *Lion* will be propelled by four screws, actuated by Parsons turbines. The turbines are designed to give 70,000 horsepower, and are placed in two compartments, separated by a center line bulkhead, watertight from keel to protective deck. The machinery is so arranged that there is in each engine room one high-pressure and one low-pressure main ahead turbine, one cruising turbine, one high-pressure and one low-pressure astern turbine. The high-pressure ahead and the high-pressure astern turbines will drive the outer shafts, while the cruising and the low-pressure ahead and low-pressure astern turbines will drive the inner shafts. There are four propeller shafts, with one three-bladed propeller on each, and the propellers are of manganese bronze, cast solid. The two outer ones are placed about 20 feet forward of the two inner propellers, and they are all arranged to turn outboard when the ship is going ahead. Steam will be generated in forty-two watertube boilers, arranged in seven groups of six each. The fuel capacity is about 3,500 tons, and this will give the ship a wide range of action. The engine rooms will be provided with the most up-to-date auxiliary machinery, including main circulating engines, main air pumps, evaporators, distillers and fire and bilge pumps. The propeller shafts pass through the hull and are exposed for a considerable length, each shaft being supported in very large cast steel struts of the "A" pattern, without any out bossing of the hull. The stern has a very long overhang for housing the two rudders, which are of the balanced type, and unsupported outside the hull. This double rudder system of steering has proved a great success, and is being adopted in all the latest English battleships.

The *Lion* was set afloat at Devonport Dockyard on Aug. 6, 1910. The difference between the original "battle cruisers" and their successor is almost incredible. The mounting of the main battery is entirely novel. Four guns are paired on the center line forward, the second two firing over the first two; then come the single tripod mast and two funnels. The third pair of guns, also on the center line, is between the second and third funnels, and the last pair of guns is mounted aft in the usual way. There will be a short mast behind the third funnel for signaling. The secondary battery will be mounted in the superstructure, and there will be a notable absence of bridges. The diagonal arrangement of placing the 13.5-inch turrets has been abandoned in this ship.

"Amervan" Ferro Vanadium "The Master Alloy"

Vanadium Steel made from the right kind of Ferro Vanadium and submitted to the right kind of heat treatment is the highest type of steel known to the metallurgical world. There is absolutely nothing beyond it for strength, toughness, durability, freedom from fatigue and crystallization, and general all round workability.

The most important factor in making good Vanadium Steel is the quality of the Ferro Vanadium by which the Vanadium is introduced.

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MARINE ENGINEERS

SHOULD SPECIFY THESE METALS—

VICTOR VANADIUM
BRONZE CASTINGS

This Bronze composition is particularly adapted for Modern Marine Service, and is rendered tough, strong and uniform by the incorporation of Vanadium, which is considered the greatest of all scavenger alloys, imparting to the metal greater wearing qualities. This bronze is ten per cent lighter in actual weight than any other bronze casting of the same pattern.

These castings can be forged.

The structure is close and clean, capable of withstanding high pressure for valve service.

A cylinder 9-16 of an inch thick, three inches in diameter and fifteen inches long has been subjected to a pressure of nine thousand pounds.

TENSILE STRENGTH on 1" Section:
56000 to 65000 lbs. per square inch.

ELASTIC LIMIT:
22000 to 34000 lbs. per square inch.

This metal is used in submarine vessels in Japan, Austria, Russia and every vessel of this type in the United States.

VICTOR VANADIUM
NON-CORROSIVE SILVER METAL

This Metal is non-corrosive and is particularly useful for sea-going service.

It finishes to a silver color and takes a high polish whose lustre can be maintained quite readily by simply rubbing, adding greatly to its usefulness and effect as ornamental hardware for marine use

It is an ideal metal for propellers, for it withstands salt water and all vegetable and mineral acids, nitric acid excepted. It is of great strength and toughness and should be used for valves and couplings for fire apparatus on account of its non-corrosive qualities, in place of nickeled castings, as nickel finally peels off, and this metal not being plated, cannot peel.

TENSILE STRENGTH:
66000 lbs. per square inch.

ELASTIC LIMIT:
36000 lbs. per square inch.

This metal will be found indispensable to marine service when once used.

WRITE FOR CATALOG

VANADIUM METALS COMPANY

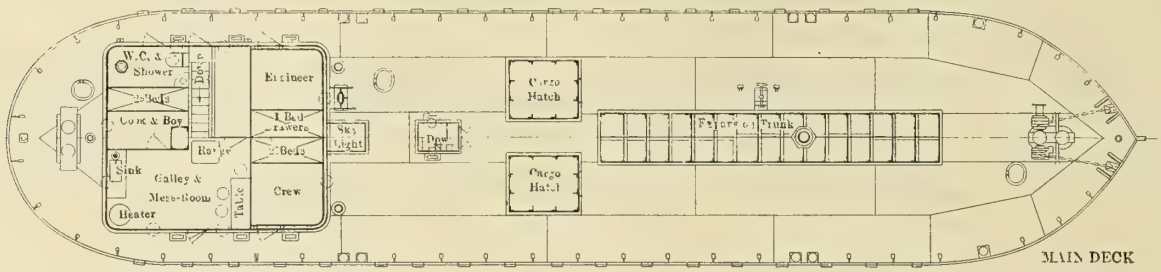
FRICK BUILDING

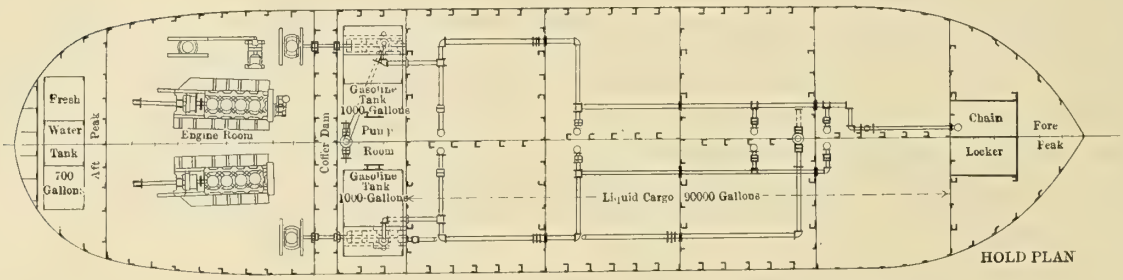
PITTSBURGH, PENNA.

A TWIN-SCREW OIL BARGE.

The Harlan & Hollingsworth Corporation of Wilmington, Del., have designed and built for the Pure Oil Company of Philadelphia a twin-screw power lighter for coastwise and canal service. The vessel is 100 feet over all, 93 feet on the waterline, 23 feet beam molded, 12 feet 6 inches depth molded, and is designed to carry 90,000 gallons of oil in bulk and, at same time, a deck load of from 250 to 350 barrels of oil on a draft of 10 feet.

The hull is built entirely of steel, the only exception being the pilot house and captain's room. She is divided transversely by eight steel bulkheads. Four compartments are intended for liquid cargo, and one of them is fitted with hatches so that any other cargo can be carried; an expansion trunk is fitted over the first three which carry liquid cargo only; a longitudinal bulkhead divides each hold and each has the necessary manholes, ventilators, sounding holes, etc. The cargo hatches have oil-tight covers, vents and sounding holes. Peak buoyancy tanks are provided at each end of the vessel, the pump room being located abaft the aftermost cargo tank. A 24-inch cofferdam abaft the pump room prevents any leakage of oil from holds, pumps, or gasoline from tanks, finding its way into the engine room, where the pumping, electric lighting and propelling machinery is located.





The pumps are of the rotary type and are each driven directly by independent engines located in the engine room, through shafting passing through the cofferdam. The pump room is entered from the deck by a steel skylight booby hatch, having an iron ladder. Deck lights and vents are also fitted over pump room.

A steel deck house is located over the engine room, giving entrance to the latter and also providing accommodation for the engineer, crew, cook, toilet and kitchen. This house has a steel roof. Two down-cast vents, one uptake vent, a steel skylight, with emergency escape and deck lights, are provided for the engine room.

Two independently constructed tanks, each containing 1,000 gallons of gasoline (petrol), are located in the pump room for supplying the propelling, pumping, electric and hoisting engines. An independent fresh-water tank is located in the aft peak and contains 700 gallons. A force pump in the kitchen draws from this tank and fills the auxiliary tanks for the kitchen sink, toilet room and hot-water heater. A deck hand fire pump and a Fairbanks' rotary gasoline (petrol) driven deck fire pump are installed, the latter being driven by means of a sprocket-chain attachment from the hoisting engine.

The kitchen is fitted with a range, sink, dressers, mess table and an Ideal heater, supplying hot-water heat to all quarters and the pilot house through suitably-placed radiators.

Metal berths are fitted in all living quarters, with metal lockers for the crew, the officers having wood drawers and desks, the floors being covered with linoleum. The toilet room has an asbestolith floor and is provided with a shower. Brass-framed sidelights are fitted to all rooms in the deck house, pilot house and captain's room, having sliding windows.

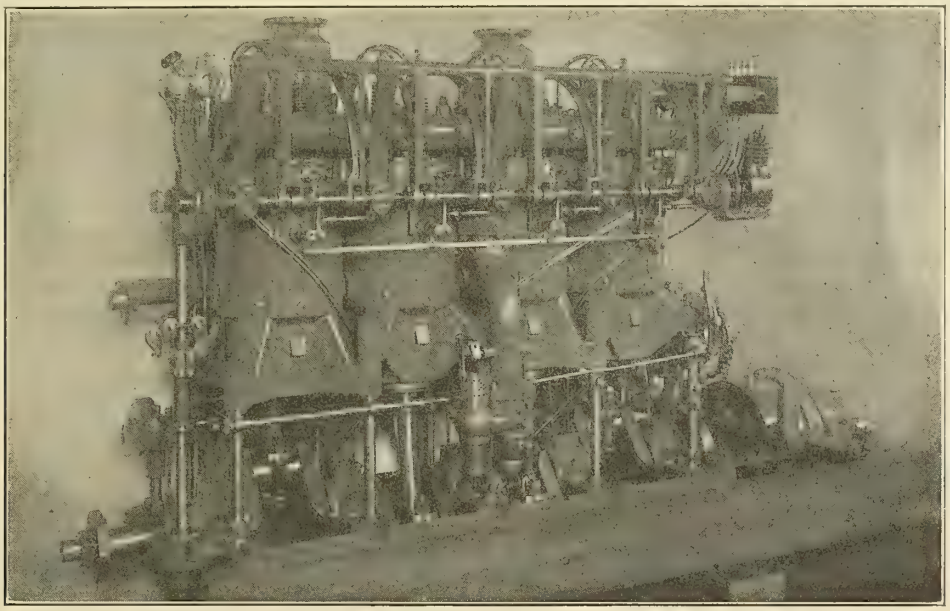
The pilot house has the usual compass, clock, speaking tube and gong and jingle communication with the engine room, also a hand-steering wheel and drum, with rope leads and purchase blocks to the steering tiller. The rudder is of cast steel of the balanced type, the weight being carried at the main deck, while an extension stock reaches to the tiller at the top of the deck house.

The vessel is equipped with a square-sterned metallic lifeboat, having hinging davits, stockless anchors and anchor crane, towing and mooring bitts, pump brake windlass, fog bell, hose, life preservers, ring buoys, McLaughlin fire pails, etc., as required by the United States Inspection Service. Electricity is used for lighting the vessel, also for the running and towing lights; portables are provided for the holds, etc. A heavy wood pole mast and cargo boom, with stays, shrouds, guys and cargo fall, with the necessary blocks, are provided, also jack and ensign staffs.

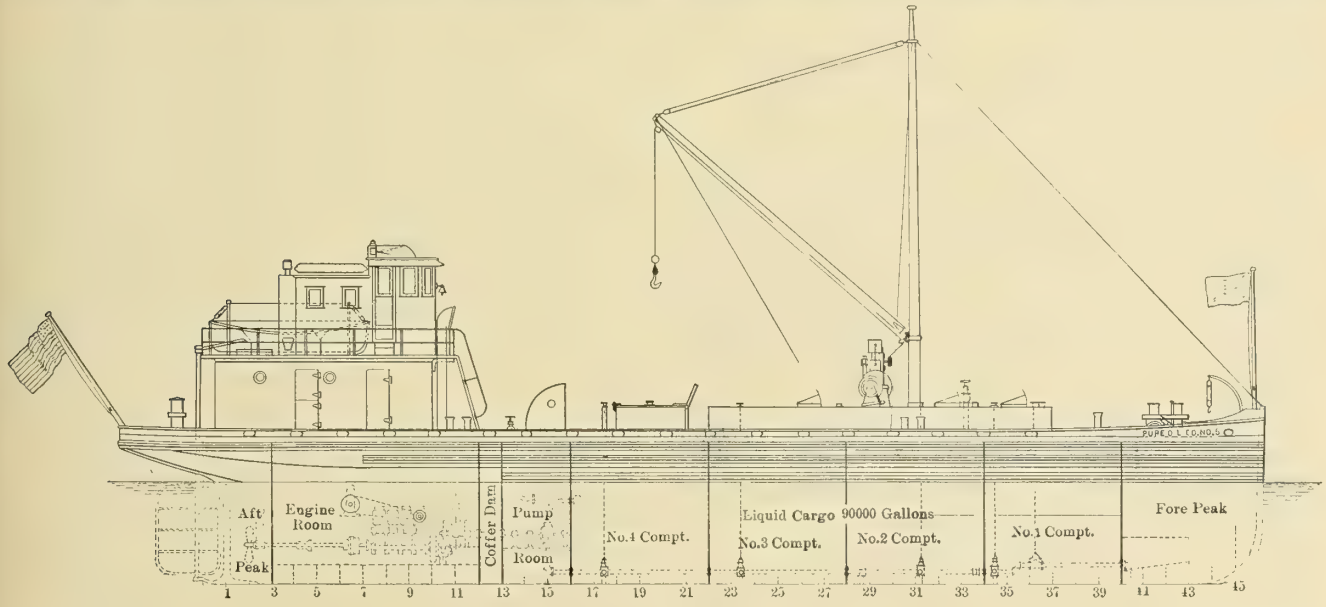
The propelling machinery consists of two R. H. and L. H. four-cylinder, four-cycle engines, built by James Craig of New York. The cylinders are 9 inches bore by 10 inches stroke, and are capable of developing between 75 and 100

horsepower. The cylinders are separate and mounted on forged steel finished columns. Make-and-break ignition contained in detachable bronze plugs is provided with means for varying the timing of the ignition when engines are in operation. Nickel steel inlet and exhaust valves are contained in the cylinder heads, and all are mechanically operated. Forged steel finished crank shafts and connecting rods, bronze rotary circulating water pumps, a bronze governor and hand-control speed device and carburetor, all suitably arranged to properly control the engine speeds, are fitted. The cylinders, cylinder heads and exhaust pipes are properly water jacketed, carefully machined and fitted. These engines are fitted with a very superior and powerful friction reversion clutch and thrust-bearing outfit. Each cylinder is fitted with an independent cylinder oiler and connections. There is a mechanical oiler and copper tubing for oiling the pistons and wrist pins. There is also provided on the working side of the engines a suitable oiling manifold, valve devices and copper tubing for oiling the main bearings and crank pin boxes. All the main bearings and crank-pin boxes are babbitted with the best genuine babbitt metal, peened, bored and accurately scraped to fit the crank shafts. All the cams, rollers, etc., for operating the inlet and exhaust valves and igniter mechanisms, are made of the very best tool steel finished and hardened.

These engines are designed with a lower main exhaust port, controlled by a mechanically-operated valve device, permitting the exit of the exhaust only, and the valve is closed on the suction stroke of the piston. By this means the heat conditions of the engines are properly attended to, as 90 percent of the heated and burned gases pass out through this lower exhaust port. This arrangement also has the advantage that no valves are opened against any great pressure, and the regular exhaust valves in the cylinder heads are not enveloped by any great heat, also the wear and tear on the valve mechanism is greatly reduced, thereby insuring smoother operation and longer wear of the engines.



ONE OF THE CRAIG ENGINES.



The cylinder heads are fitted to the cylinders by means of a recessed joint and copper gaskets, and bolted down by six 7/8-inch-diameter steel studs and nuts. The circulating water passes from the cylinders to the cylinder heads by means of

copper tubing and special outside connections, thereby eliminating any possible water leakage to the cylinders.

The propeller shaft is of steel, bronze lined, and is supported at its outer bearing by a strut. The propellers are of bronze. Air compressors are arranged and operated by the engine, with suitable air reservoir, whistle and pressure gage, all complete, the exhaust piping and muffler being carried up through an uptake vent abaft the captain's room.

The pumping machinery consists of two rotary pumps of the Fairbanks make, together capable of pumping 30,000 gallons per hour against a head of 30 feet. The gasoline (petrol) engines, which drive these pumps, are separated from the pumps by a cofferdam and are connected directly to the pumps by a driving shaft, passing through the cofferdam. The engines are water-cooled, and are provided with the usual starting devices, mufflers, etc.

The hoisting engine is also of the Fairbanks make, located on deck and protected by a permanent shield. This engine is fitted with a single drum, having an overhauling device, and is capable of hoisting without the aid of a purchase a load of 500 pounds at a rope speed of 150 feet per minute. This hoister, by means of a sprocket-chain connection, can operate a centrifugal deck fire pump, and the anchor windlass also.

The stems of the valves for the liquid fuel suction pipes are carried through the tops of the cofferdams and operated by a wheel. The general layout of the piping is shown in the illustration.

This vessel was designed for a speed of about eight miles per hour, and went into service early in January.

At the annual meeting of the National Marine Engineers' Beneficial Association, which was held in the Planters' Hotel, St. Louis, Mo., Jan. 16 to 20, the following officers were elected for the coming year: National president, William F. Yates, New York; first national vice-president, Art Hyde, Cleveland, Ohio; second national vice-president, George H. Bowen, Port Huron, Mich.; third national vice-president, Charles N. Vosburgh, New Orleans, La.; national secretary, George A. Grubb, Chicago, Ill.; national treasurer, A. L. Jones, Detroit, Mich.

The convention adjourned on the evening of the 20th, to meet at Detroit, Mich., January, 1912.

The Repair of a Worn Plate and a Leaky Joint.

Engineers who are stationed away from home have frequently to encounter a good many difficulties which would be rather outside the experience of those who live and work near our great mercantile marine centers. For one thing, the means and appliances of repair are not available at out-of-the-way ports, materials are very limited, labor is oftentimes unskilled, and, in many cases, time cannot be spared to accomplish more than a makeshift repair. Such a position calls for a considerable amount of independent action and a quick eye to see the possibilities of a most unpromising situation. Such minor matters as, for example, a knowledge of Krooboy's lingo and a working acquaintance of methods of persuasion adapted to the untutored mind, are taken for granted.

As an example of the difficulties which happen in unfrequented ports may be mentioned the case of a plate very badly worn and a joint leaking on a ship's side midway between the load and light waterline. This occurred on a large steam lighter (1,000 tons), and the cause of the trouble was due to the continued rubbing of the lighters against the craft, and also against other steamers. The effect of this was that the rivet heads and the edges of the plate were worn down, causing it to break away at the seam.

This happened when the ship was busy loading. As soon as the leakage was noticed the ship was listed until it was cleared of the water and loading operations had, of course, to be suspended until the leak could be repaired. The opening of the seam extended for about six feet, and it was also seen that the plate was very badly worn locally. In order to effect a repair, a piece of plate about 8 feet long by 2 feet 6 inches wide was obtained and joggled slightly, or given a set along its lengthwise center line. Holes were then drilled in the ship's side where they could best be placed for rivets, and the plate was fitted, marked off and punched with a hand punch. The holes could, of course, have been just as well drilled, as the tackle was available; but it seemed to be a longer job. The plate was then bolted up onto an insertion joint laid along the outside of the ship. After the cargo had been lightened more holes were drilled through both the plate and the ship's side, rivets were secured and a permanent repair was made of the job. Of course, before riveting, after the removal of cargo (at the end of the trip), the insertion joint was removed because in order to make a permanent repair it was necessary to calk the plate at all its edges.

THE MECHANICAL HANDLING OF FREIGHT.*

BY S. B. FOWLER.

STEAMSHIP TERMINALS.

Turning to steamship or water-borne freight terminals we find the same conditions as at railway terminals of too great cost in handling goods, and too little space for the present traffic without even considering the future. The congestion present at a busy pier and the long delays experienced in delivering or receiving shipments are well known. The manager of a large teaming company in New York told me not long ago that a wait of two or three hours at the pier was not unusual, and he had known of instances where a team had waited an entire day and at the end came away without its load.

The excessive costs of handling freight form an important part of the total costs as in railway transportation. The lack of sufficient capacity for handling the merchandise, together with the slowness of manual handling, made slower still by the congestion and consequent rehandling, causes the delay.

Speed in loading and unloading vessels is of the greatest importance, for, differing from railway transportation, the vehicle for carrying freight is one large unit, and all goods must wait until the last box is loaded. The motive power also lies idle during this wait. The motive power in railway transportation is in small units, all of which can practically be in use while cars are being loaded. The interest on the large investment represented by a modern steamship, while idle in the dock a day or so, often is an important factor in the profits of a trip. The steamship terminal differs from a railway terminal in that it is necessarily of less area, and a combination terminal as well. Over the same pier floor is handled all classes of inbound, outbound and transfer freight at the same time.

In the use of machinery at docks this country is far behind Europe. All large ports of Great Britain and of the Continent are well supplied with cranes of one sort or another; some ordinary pillar cranes, other movable cranes along tracks parallel with the pier. Such apparatus, however, does not constitute a true mechanical freight-handling equipment, nor does it perform the operations required of such an installation. Its horizontal transporting movement is rather limited and does not reach inside the sheds. The use of hand trucks at these ports is still practiced extensively.

It has been the custom recently to attribute the great efficiency of these ports and their lower cost of freight handling to the handling machinery there installed. The cranes princi-

* From a paper read before the American Society of Mechanical Engineers, New York, January, 1911.

pally serve to hoist or to lower loads into the ship's hold, which is done in this country by the ship's tackle. Unless these goods are taken direct from railway cars or placed at once on cars or teams they must be taken away from or delivered to the cranes by hand trucks.

The difference in cost of unloading freight at San Francisco and at Hamburg is only about 10 cents per ton, taking the average of all goods handled at Hamburg. San Francisco has practically no machinery and Hamburg an ample supply of modern cranes. Labor is much cheaper at Hamburg, but even this is not the main advantage. Sixty-two percent of all freight entering the port of Hamburg does not pass over the piers at all. The vessels tie up at moorings in the harbor and transfer their load to so-called Rhine boats, placed alongside, hoisting and lowering with the ship's tackle—the cheapest possible way of transferring merchandise.

At the water terminal the methods of loading are practically two in number: (*a*) Direct transference to vessel from other water craft, railway cars or teams; (*b*) delivery of goods to pier and later transference to vessel. In this country the second method is generally used, direct transference being practically only from lighters used in a transfer of freight from another terminal. The usual operation, therefore, involves a large amount of handling, and much moving of small loads on trucks. Goods received at the pier are transferred to hand trucks, taken to the scales or else measured, then moved to some predetermined location and removed from trucks to be again loaded and trucked to a point where the ship's hoist can reach the load, which is then lowered into the hold. With the substitution of transporting machines much greater loads can be moved from the vehicle delivering and at much greater speeds, taken over track scales and automatically weighed, moving on to the location desired or direct to the ship's hatch, and immediately lowered into the hold. The elimination of manual labor is entire except in removing from cars or teams to the carrier, and if in the latter case the merchandise is loaded on flat boards placed on the bed of the wagons, even this handling can be done away with.

The method of unloading may be either by (*a*) direct transference to the vehicle which will move it from the pier or dock, or (*b*) direct discharge to the pier and later reloading to boat, railway car or team. In the case of coastwise traffic either method may be adopted. On the other hand cargoes from foreign ports must be handled by the second method because of the custom inspection. The advantages of employing transporting machines in unloading is apparent when contrasted with methods now in use.

The planning of overhead trackage for a water terminal is a simpler problem than devising one for a railway terminal, since while it must serve the entire area of the pier sheds as in a freight station it need extend outside only far enough to reach the holds of the vessel. Instead of the outside trackage being designed to allow for delivery or reception of goods from a hundred or more points, the only parts necessary to be reached are the hatches of the vessel, few in number. The direct trackage for reaching the hatches must be movable in a line parallel with the pier, and so arranged that they may be entered from any portion of a permanent track forming a loop or a series of intercommunicating loops, one side of which is outside of the shed.

Steamship freight is generally of larger bulk and greater weight than railroad L. C. L. freight, and necessarily heavier trackage and more powerful transporting machines and hoists must be provided. The consignments, however, are usually larger in quantity and much less sorting and classification is necessary, conditions favorable to the maximum elimination of hand labor. Rehandling by manual labor could practically be done away with, and if a direct transference between vessels and other transporting vehicles were made possible, the mechanical rehandling could be eliminated, since the transporting machine can hoist the load from the hold, carry it to the car or team and deposit it thereon. If necessary to deposit load on shed floor it can later pick it up without further rehandling and transport it to car or team or to vessel and lower it into the hold. The present cost of loading and unloading could be greatly reduced, and the capacity of the terminal increased by the handling of larger unit loads at greater speeds. The capacity could be further increased by a redesign of the terminal.

With a transporting machine stationed on the pier itself, doing the hoisting and lowering of loads, the variation of level due to tides could be ignored, since the cost of hoisting goods a few additional feet has no material effect on costs or time. Upper stories could then be utilized to advantage. As a rule a second floor is used only for warehouse purposes, with the result that all is confusion on the pier floor, due to wagons both receiving and delivering goods. In many cases the pier floor is divided longitudinally into two portions by a pit down the center, in which are placed cars for loading or unloading. Communication between these two platforms is maintained through the cars, and, if there is more than one line of them, by "spotting" them or by movable bridges.

It is suggested in the first place that no teams be allowed on the pier floor. The loads could be received or delivered at the end of the pier by the transporting machine, and the space required for the teams could be utilized for other purposes. It is also suggested that each pier shed be of two floors at least, the upper floor being better adapted for incoming merchandise, since the customs officials will then have the goods on a floor apart from everything. It is evidently as easy to transfer goods to this floor from the ship or to deliver them again to teams or cars as from the first floor. Cars to be loaded can be placed on tracks on the pier between the shed and the pier edge. The lower floor could then be reserved for outgoing freight, and tracks provided for cars to be unloaded. If desired these cars could be easily loaded through hatches in the floor of the second story. As the transporting machinery would operate on overhead tracks the cars inside or outside the shed would offer no obstruction.

It is claimed that the cause of the decline in water transportation is due to the limited facilities for receiving and delivering the goods as well as the costly delays at the terminals. If the installation of machinery and the redesign of terminals can obviate these objections will not both shipper and carrier be the gainers?

In concluding, the writer realizes that the subject has been treated in a general manner only. The problem is a broad one, and consists not merely in the installation of certain machinery, but in the study of the changes such an innovation will make in the entire operation of the transportation system as well as the effects on costs, rates and revenue. It is not simply the adaptation of an overhead, electrically-operated carrier system to the present arrangement of terminals, but rather a redesign of the terminals and a radical change in methods of carrying on the terminal business.

In solving this problem let there first be a realization of what changes mechanical freight handling might make possible, and then abandoning all old ideas and practices to take up the subject as an entirely new problem and work out the solution unhampered by tradition and prejudice. The subject deserves careful study and investigation. Every transportation company could afford, considering the economies that will be effected, to establish a separate department to work out this problem or to employ outside expert services for the purpose. The scope of such investigation and application is not limited to the mechanical and electrical features involved, but requires the services of men also familiar with all phases of the practical transportation problem.

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Just as we were going to press with this issue of International Marine Engineering our editor, Mr. Brown, slipped and fell, so injuring his head that he lay unconscious in the hospital for several days. We, therefore, ask indulgence for any mistakes or oversights which may occur.

The Modern Shipyard.

There is an old and time-worn adage that "clothes make the man," which, though not entirely correct, as we know, has some foundation in truth. The part that has foundation in truth might well be adapted to the modern shipyard by saying, "Equipment makes the shipyard."

That this statement can be questioned is evidenced by some older yards with antiquated equipment that have turned out, and still do turn out, good work economically, despite the equipment, due to the excellence of its management. On the other hand, it is undoubtedly true that other yards, with excellently arranged and modern, up-to-date equipment, sometimes fail to obtain the results expected. In other words, there are instances where equipment does not make the shipyard any more than clothes make the man; a shipyard may be a shipyard in spite of its equipment.

The truth of the adage is that, with equipment of the proper sort, the shipyard has a good start toward the results desired, and with this as a start, combined with intelligent and efficient management, the success of the yard is assured. That is the ideal that all yards are striving for—that is, correct mechanical equipment, combined with intelligent and efficient management. That this ideal is being more nearly attained every day is patent to all of us. The older yards are learning that they cannot attempt to compete with the modernly equipped yard, even with the best of management, without investing in more modern and labor-saving equipment, and the newer and more up-to-date yards are also aware of the fact that their good equipment is only one step in the right direction and, combined with this, they must have the most able management.

With recent demands of naval development and the growing size of merchant vessels, shipyards have required the latest and most efficient machine tools that the manufacturer can produce. The average lay mind scarcely realizes the size of the work that machine tools and other equipment are required to handle. In many instances the work is of such size that it is found easier to bring the tool to the work rather than the work to the tool. For work of this character some really remarkable tools have been designed, in some cases permitting large castings to be accurately machined in many places at one setting, thereby reducing the problem of handling to a minimum.

Elsewhere in this issue will be found descriptions and illustrations of several modern and up-to-date shipyards of various countries. The descriptions, though necessarily short, due to limitations of space, tend to show how shipyards in all corners of the globe are securing equipment and efficiency for handling work that leaves little to be desired. The work of a shipyard is so much more diversified and of a greater magnitude than the ordinary industrial establishment that it is probably impossible to equal them in the matter of standardizations and low costs. The organization and supervision of shipyard economies cannot be reduced to an exact science in repair work, but it is interesting to note how various yards in different countries are each by independent methods reducing the art of shipbuilding, whether it be a steam yacht, freighter, ocean liner or battleship, to as near an exact science as human ingenuity can make it.

The engine and boiler rooms of a modern ocean liner or battleship contain generating equipment that would dwarf any but our largest stationary plants; but this forms a smaller mechanical problem than the machinery by which these are made as well as the machinery by which the vessel itself is made. The success of the modern yard is, in no small measure, due to the marvelous development of machine tools, both in this and other countries, for all classes of work to be found in a shipyard.

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THE CONTROL AND EQUIPMENT OF WATER TERMINALS.*

BY H. MC L. HARDING, CONSULTING ENGINEER.

Waterways are supposed to be public highways, but with the terminals under private and corporate control they are more like toll-roads with a bar and a collector at each end—free between the gates but restricted at the ingress and egress. Channels alone do not give transportation. They are only efficient when combined with adequate terminals, properly equipped with transshipping machinery and storage facilities.

Terminals are as important as channels. In fact it may be said that terminals control the channels; hence the control of the terminals means the control of the waterways. This fact should never be forgotten and should therefore be of no little interest to all civic communities. They should preserve for future public use the few wharves and piers not yet beyond their control, and in addition should further develop the unimproved terminal frontage of harbors, and unused portions of the river bank near cities and towns. Wherever possible terminals should remain in the control of either the city or State or else in a joint harbor commission composed of representatives of each.

It is to be noted that various harbors in Europe are under the control of harbor boards which are public or semi-public organizations and a majority of the directors may be considered as officials who are responsible to the State or public authority. While there is a great variety of harbor management in foreign countries, yet it may be said that with a few exceptions they are under the control of a board selected wholly or in part by the government.

In the United States, the Federal Government has expended, and is still expending, enormous sums annually in maintaining and improving channels, and it seems as though the cities and sections of the State benefited should provide and equip the terminals which afford the only path for the movement of freight to the waterways. Although a large proportion of the water frontage has been diverted from public to private or corporation uses, yet the locations that remain can be made far more efficient by the installation of proper freight handling machinery, which machinery will not only transfer the freight between the vessel and the shore, but also carry it overhead to the hinterland, where there can often be obtained ample room for the receiving of the freight from the shippers, and the storing of freight waiting for railway transportation or for the drays of the consignees. The freight can move equally well in both directions. Back upon this rear land can be erected warehouses and buildings of several stories and freight can be carried by overhead conveying a distance of several thousand feet at less expense than it costs by manual labor to take from the vessel and assort upon the near-by pier floor.

It is well to consider the whole significance of the above statement as to the performance of such machinery. It means that a vessel can be loaded or unloaded in one-half, or less, of the time consumed at present; that as freight does not have to be stored upon the pier, the drays need not come upon the pier or shed floor; that a much smaller pier will do the same amount of work; that there will be an avoidance of congestion; that the expense of handling will be greatly reduced. To sum up, that upon a narrow wharf or pier with a narrow bulkhead it will be possible to more than double the pier capacity and reduce the time of handling to less than one-half. This will increase the efficiency of the pier more than four times.

A roadway at the head of the pier or even railway tracks, even when along the river bank, will not prove any barrier to the transference of freight to or from buildings or space beyond the roadway or tracks, as all movements being overhead the freight can pass above cars or street traffic without any interference and with the greatest economy. It costs but little more by properly designed conveying machinery to transfer freight five hundred feet than it does fifty, and but little more also to deposit the freight in the second or third story of the warehouse than it does in the first. The buildings, however, should be so designed and constructed that the machinery can be installed to the greatest advantage.

It has been the custom almost universally abroad for the cities or government to install this machinery and to charge commerce sufficient for its maintenance. On account of this we see the important ports of Europe equipped with many kinds of machinery, thereby greatly facilitating the transference of all kinds of freight. Machinery, such as a gantry crane, will pick up all kinds of freight of every description, whatever may be the size, shape or weight. Such freight is hoisted from the vessel, placed in the railway cars upon the pier, or else swung upon the platform in front of the sheds.

It is interesting to note that there is not anything which enters into the cargo of the ship, which contains every thing which ministers to the necessities or luxuries of man, which cannot be handled by machinery. While the gantry or jib crane is doing excellent work, its in-reach is limited and it cannot take the freight, assort, carry, deposit and tier it upon any square foot of floor of the pier shed, warehouse, while simultaneously other carriers can be hoisting, conveying and following each other so closely that there would be no waiting or delay. The new installations of machinery do this, effecting a saving of at least seventy percent in labor.

In a paper recently read by Mr. John Llewellyn Holmes, before the Institution of Civil Engineers of London, he states that "In time, dock companies will be expected to provide plants not for discharging and loading but for conveying from and to the ship's side as quickly as possible." That is to say, the freight must be conveyed to and from any portion of any of the receiving sheds or warehouses, even though they be located at quite a distance from the ship's side.

The State or city which owns terminals should equip and own the machinery for thus transferring freight. It greatly increases the efficiency of its property. The ship-owner or lessee cannot be expected to do this except where there is a long lease. Otherwise terminal companies with properly restricted authority should be found for this work.

In the report by Mr. F. W. Cowie, Chief Engineer of the Harbor Commissioners, one of the highest authorities on terminals, it is stated that:

"At a recent engineering convention, one of the most eminent engineering authorities made the statement that the weak point in the railway transportation systems of North America was their terminals and that the most important weakness of the terminals was the lack of freight handling appliances.

"When it is considered that in the Montreal harbor sheds the quantity of actual freight handled annually amounts to over two million tons, it is apparent that any material saving in the cost of handling freight would immediately show beneficial results to the port."

It is to be noted in this report, that Mr. Cowie has already installed freight handling machinery and has recommended the equipment of new piers with mechanical appliances. All important railways have as a part of their transportation systems water terminals.

There are many precedents for city owning and controlling water front terminals. The port of New Orleans extends nearly fifteen miles along the Mississippi River. The State of Louisiana owns practically all the water front with the exception of 4,760 feet, owned by the Illinois Central Rail-

* Many of the facts stated in this article are taken from the Report on Terminals by Herbert Knox Smith, Commissioner of Corporations of the United States.

way Company, and this is subject to expropriation by the State.

The wharves and sheds at Preso street were built by the New Orleans and North-Eastern Railway. These have been expropriated by the State. The wharves and sheds of the Louisville and Nashville near Erato street have also been expropriated by the State, to be effected in 1915.

The State also owns nearly six miles of public wharves, most of which are covered by steel sheds. The river front of New Orleans is administered by two State Boards. First: The Board of Commissioners of the New Orleans levee, which has a right to acquire land and build levees.

Second: The Board of Commissioners of the Port of New Orleans, that prescribe rules for loading vessels and controls the commerce obtained by the public wharves. The public Belt Railroad Company Commission, a municipal body, has control over the New Orleans public Belt Railroad.

The public wharves are built from the height of the levee outwards. By December 31st, 1909, there were twenty-two public wharves that had been thus constructed.

San Francisco has a water frontage of 4¾ miles for commercial purposes. The total length of the wharfage is over 12 mile exclusive of bulkheads. The sea-wall and the sea-wall lots are owned by the State of California and are under the control of the State Board of Harbor Commissioners. The entire construction, ownership and control of the piers from the bulkhead line outwards to the pier-head line are in the State through the Harbor Commissioners, who also control and operate the Belt Railroad.

A small proportion of the piers and docks of San Francisco is owned and operated by private individuals or corporations. The Harbor Commissioners are directed to construct and maintain wharves and transshipping facilities and dredge docks as the wants of commerce shall require, and may enact reasonable regulations concerning the management of the property of the State. They fix the rate of dockage, wharfage, cranage of these wharves, etc., and collect the revenues therefrom.

So far as can be ascertained, only two piers along the water front are owned by private parties.

In March, 1910, out of 176 tenancies granted by the Commission of San Francisco on wharves and portions of the sea-walls, exclusive of ferry houses and slips, 167 were on a thirty-day tenancy called assignments. These monthly assignments give merely a preferential use of the assigned wharf space, which is open to others when the tenant is not using it. The above system practically results in open wharves along the active water front, available for use by any vessel at rates fixed by the Commission.

The policy of New York City is to own the piers along the water front and to retain them. The present policy is to reduce the length of the leases. Baltimore has also commenced to construct piers and to afford facilities for the unobstructive flow of commerce.

No merchant marine can be effective, even though heavily subsidized, unless the cities provide terminals properly equipped with the latest and most modern transshipping machinery, warehouse with reasonable charges, railway connections, and a proper harbor board to see that no unnecessary charges are imposed upon commerce.

If a vessel cannot quickly find a convenient berth for loading or discharging its cargo, the time lost and the expense of handling the freight greatly nullify other advantages. The ports of Europe are open to vessels of all nations. They are fully equipped with machinery and offer inducements to all to make use of their ports. Even in the same country there is commercial rivalry between its different cities. Bonds are issued for the construction and the equipping with suitable mechanism.

In most cities of the United States there exist paved streets along the water front for freight movements, but the freight cannot get to the water's edge except bp permission of private or corporate interests and upon such terms as they may dictate. If cities can purchase and acquire land for the streets, should not the termini of these streets, being also the terminals of the waterways, be common to all with proper charges equivalent to the taxes on land?

The following quotations briefly sum up the situation:

"The commercial future of the city is dependent upon its port facilities.'

"Transportation efficiency is a terminal problem."

"He who can most economically and quickly reach the markets of the world can control the commerce of the world. A decrease in transportation expense not only facilitates commerce but creates commerce and manufacture."

ENGINEERING SPECIALTIES.

A New Drive for Flat Twist Drills.

The questions connected with using and driving twist drills, forged or twisted from flat bars of high-speed steel, are probably receiving more attention from mechanics at the present time than any others connected with the use of tools. Although attempts to solve the problem of drive have been numerous—complicated chucks have been designed to hold and drive the rough end of the flat bar of steel; the shank ends of the bars have been spirally twisted and machined to form taper shanks fitting regular taper sockets; more or less cumbersome taper shanks have been soldered or riveted to the shank ends of the flat twist drills—none of these methods has seemed to settle the matter beyond the possibility of further question.

The Cleveland Twist Drill Company, of Cleveland, Ohio, has recently applied for patents on a new device for driving flat, taper shanks that are tapered both on the flat sides and round edges. These shanks are regularly furnished on this company's Paragon flat twist drills, and are driven by sleeves or sockets internally equipped with flat taper holes, accurately fitting the shanks and externally tapered to fit standard taper sockets or spindles. In the case of large diameter flat twist drills having No. 6 shanks, this drive was found to have certain disadvantages, as it made necessary the use of cumbersome extension reducing sockets to adapt the large taper shanks to the drill press spindles, which seldom have a taper

hole larger than No. 6. To overcome this difficulty as well as to provide additional driving strength is the twofold object of the new device.

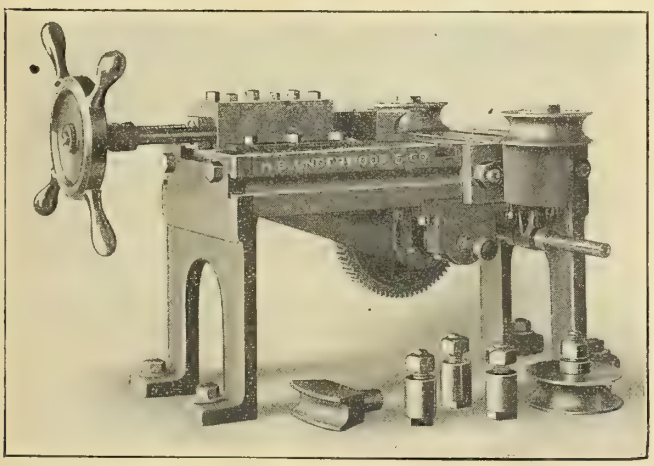
To this end both the No. 5 and No. 6 Paragon shanks have been redesigned the same length as regular taper shanks, the taper on the round edges being regular Morse taper as formerly. When, therefore, this modified shank is inserted directly in the spindle the upper end of the shank is received and driven by the driving slot in the spindle just as is the tang of an ordinary taper shank drill. This alone would constitute a strong and practical drive but for the lack of support the shank would have on its two flat sides at the lower end of the spindle. To provide against the resultant possibilities of vibration and wear between the shank and spindle, and to furnish a powerful additional drive at the lower end of the shank where its cross sectional area is greatest, a new and original type of socket, called the Paragon Collet, has been evolved.

As shown in the illustration the collet consists of two lugs projecting upward from a flattened disc through which is cut a rectangular hole to receive the Paragon shank. The lugs have rounded outside surfaces ground to standard taper and flat inner surfaces tapered to fit the flat taper shank. The groove is provided to receive the point of a drift key in case the collet should stick in the spindle. When the collet is on the shank the combination is practically an interchangeable taper shank with unusually long tang.

The additional drive is provided by means of an extension projecting (upward in the case of vertical drilling) from the circular base of the collet. This projection mortises into a slot cut across the end of the spindle conforming to the standard slots now being put in the spindles of heavy-duty drill presses by several well-known manufacturers. That this tongue-and-groove drive at the large end of the shank is very much stronger than any drive on the tang could possibly be is made evident by a single glance at the figure. The collets without this extension will fit any spindle or socket, and will be furnished to those whose spindles are not fitted with slots when this requirement is plainly specified, but they will, of course, not have the additional driving strength otherwise afforded.

Power Bender and Straightener.

This machine for bending pipe, structural iron, round and flat bars of various kinds and sizes has been developed after considerable experience with different types of mechanical appliances in this field. It is capable not only of bending but also of straightening material in a quick and decidedly efficient manner. Instead of requiring a multiplicity of dies or formers, as in most machines, it is only necessary to have on this machine a set for the different diameters. These may be set in different locations and permit of bending an infinite variety of shapes as well as radii. It is belt driven, with a tight and loose pulley on the shaft. The ram is actuated by an eccentric shaft of small throw and moves with a fixed stroke. The shaft is powerfully back-geared, giving the ram a tremendous power. Sliding in this reciprocating ram is another which carries the former to be used, and this is moved in or out by a screw operated by the hand-wheel. This gives a very delicate means of adjustment in manipulating the work and bending to the exact requirement. Any number of pieces can be bent exactly alike by noting the last position of the hand-wheel. But little skill is required to operate this machine; there is no complication and nothing to do but move the pipe along and turn the hand-wheel to suit the requirements. The formers or resistance studs on each edge of the bed slide in a "T" slot, and "T" slots are also made across the bed so that formers can be fastened therein and thus allow of many different arrangements. The machine is manufactured by H. B. Underwood & Company, 1025 Hamilton street, Philadelphia, Pa.



UNDERWOOD BENDER AND STRAIGHTENER.

Lighting Steamship Piers.

Owing to the nature of the work on steamship piers and the quantity of labor frequently employed, good light is very necessary. Various illuminants have been tried, probably the most recent being the flaming arc lamp, which is used on account of its great brilliancy. An excellent example of such illumination is afforded at the new pier of the Fabre Steamship Company, foot of Thirty-first street, Brooklyn, N. Y. This is probably the largest pier in New York Harbor,

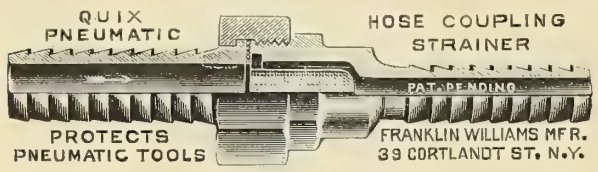
PIER ILLUMINATION.

1,476 feet long, 150 feet wide and 35 feet high. Being only one story in height, it is lighted during the day by means of skylights. In the autumn and winter it becomes necessary to make use of artificial light as early as four o'clock, and not infrequently during the day in cloudy weather. The system which has been in operation about three months consists of twenty-four flaming arc lamps, twenty-two of which are hung inside the building and the other two outside. The lamps are in two parallel rows, eleven in each row; are hung about 120 feet apart, and the distance between the rows is 50 feet. Current is taken from a 2,200-volt, 3-phase, 60-cycle alternating-current transmission line, stepped down to 115

volts by a transformer. The lighting is controlled by five control boxes, so wired that three of them control four lights each and two of them six lights each, the lamps being connected two in series. It was thought at first that the elevated platform would throw such a heavy shadow as to make the proposed plan of hanging the lamps quite impossible, but the lamps, which hang about 50 feet from the platform, throw such a penetrating light as to almost entirely overcome all shadows. This lighting system was furnished by the Western Electric Company, New York.

Quix Pneumatic Hose Coupling Strainer.

In the use of pneumatic tools considerable difficulty is experienced by loose pieces of foreign matter entering the delicate mechanism. To overcome the loss of time and expense caused by this, the "Quix" combination hose-coupling strainer

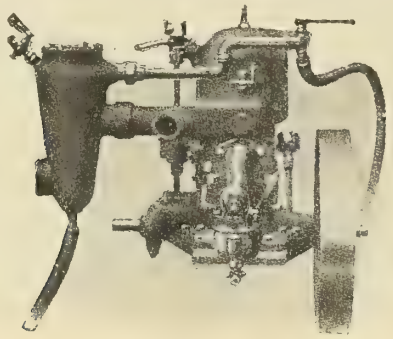


QUIX HOSE STRAINER.

was designed. It is a substantially made brass hose coupling fitted with a renewable wire strainer. This strainer is deep and cup shaped, and has ample area between its sides and the inner walls of the male end of the coupling, so that an accumulation of dirt will not reduce the air passage until the strainer is filled. These strainers are manufactured by Franklin Williams, 39 Cortlandt street, New York.

A New Exhaust Silencer.

The accompanying illustration shows the "Hydrex" exhaust silencer, as adapted to internal combustion engines. It is claimed for this silencer that a clean, free exhaust is obtained



HYDREX ENGINE SILENCER.

without detriment to the free flow of gases. The gases are led out from the cylinders gradually with increasing expansion and completely relieved of their heat by even admixture with cold water vapor until, when exhausted through an opening in the boat side above the water, practically all noise and odor are removed. It is claimed that this device is adapatable to any size or type of motor, with either two or four cycle, and can be placed in any convenient position in the boat. This silencer is manufactured by the Hydrex Silent Exhaust Works, 126 Liberty street, New York.

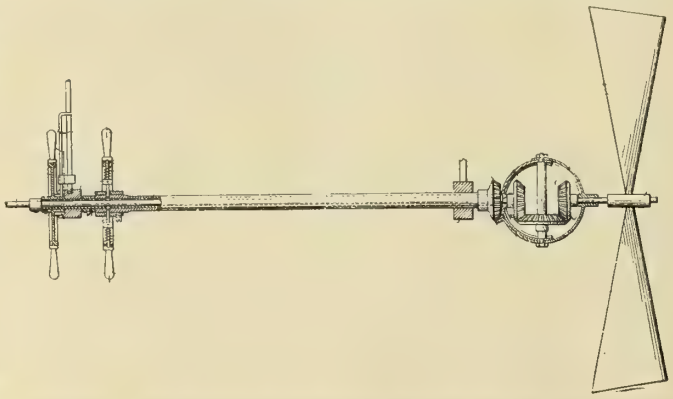
SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

974,961. GEARING FOR PROPELLERS. WILLIAM A. HALL, OF LOSS ANGELES, CAL., ASSIGNOR, BY MESNE ASSIGNMENTS, TO AMERICAN AERIAL COMMERCIAL COMPANY, OF LOS ANGELES, CAL., A CORPORATION OF ARIZONA TERRITORY.

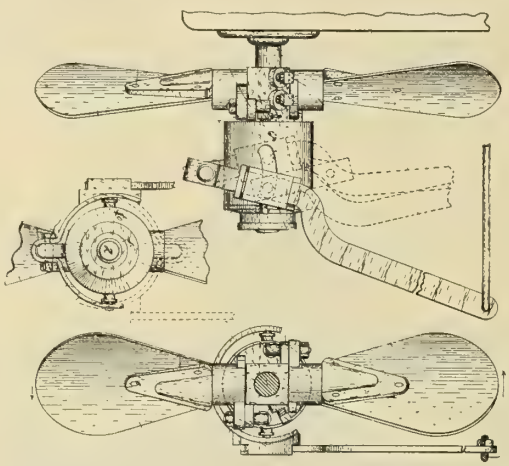
Claim 1.—Two yokes pivoted together, a driven shaft in one yoke, a bevel gear on said shaft, an idle gear carried by one of said yokes meshing with the first gear, a driving shaft journaled in the other yoke, a



bevel gear on the driving shaft meshing with the idle gear, a segment gear on the yoke which carries the driven shaft, an intermediate tube attached to the other yoke, an outer tube, and a gear on the outer tube meshing with the segment gear. Six claims.

975,039. REVERSIBLE PROPELLER FOR BOATS. PERCY W. HODGKINSON, OF ROCHESTER, N. Y., ASSIGNOR TO CHARLES D. CAMP, OF ROCHESTER, N. Y.

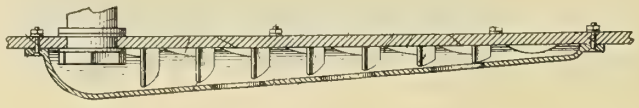
Claim 1.—In a propeller for boats, the combination with the blades, of controlling mechanism therefor embodying a pivotally mounted re-



versing yoke arranged wholly in the rear of the blades and on the propeller shaft. Twenty-five claims.

977,976. UNDER-WATER EXHAUST AND MUFFLER. JOHN O. SMITH, OF CLEVELAND, OHIO.

Claim 2.—An under-water exhaust fitting comprising a chamber to receive the exhaust, said chamber decreasing in depth as it progresses toward the rear of the fitting, a plurality of tapered ports or openings

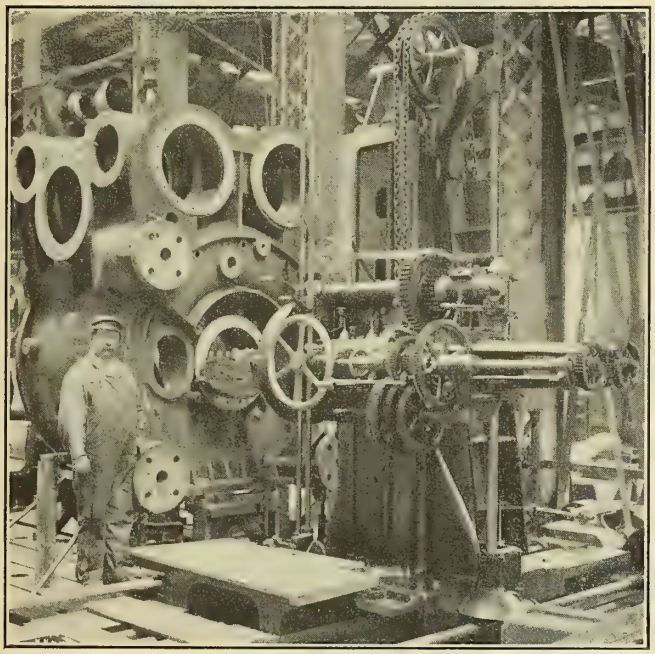


along the top of the chamber at each side thereof, a plurality of baffle plates within the chamber and associated with said ports or openings to deflect the exhaust therethrough, and a port or opening in the bottom of the chamber. Four claims.

SHIPYARD EQUIPMENT SUPPLEMENT

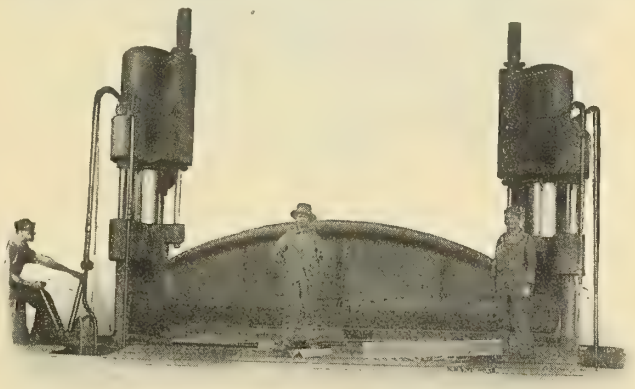
In the following pages may be found the latest information concerning some of the most useful and efficient tools used in shipyards

With the rapid development of the modern steamship the question of mechanical equipment for shipyards has become a paramount one. The main generating units of some modern ships have a horsepower far beyond any single units built for stationary service. The size of this machinery is, however, not as wonderful as the tool equipment necessary to handle this machinery efficiently and economically. From the structural work of the framing and the plating of the hull to the final installation of the engines, boilers and other mechanism that go to make up the propelling, operating and controlling machinery of the modern vessel, is represented the product of the best and most powerful machine tools that human ingenuity has devised.



NILES-BEMENT-POND HORIZONTAL BORING, DRILLING AND MILLING MACHINE.

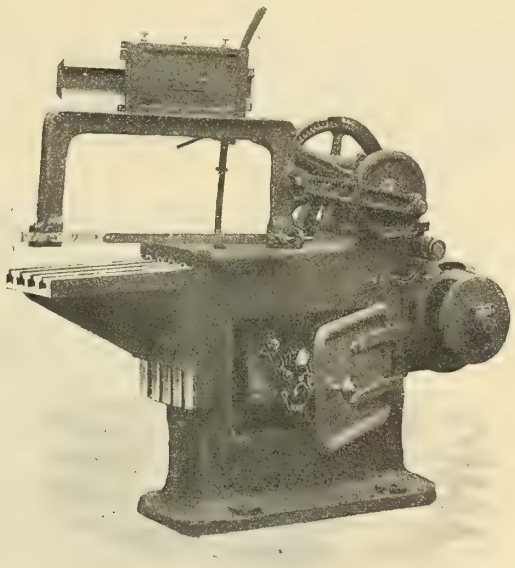
The machine and plate shop work is of such size and character as to present an entirely different problem from ordinary machine shop operations. In many cases the work is so heavy that it is found desirable to bring the tool to the work, and for this class of work special tools have been devised that permit the casting to be drilled, bored, or milled, as the case may be, at one setting and with a minimum handling cost. The increasing size of engines, whether reciprocating or turbine type, calls for heavy special tools. In no other industrial establishment can be found such large and diversified numbers of tools, from the foundry to the machine shop, including the smallest of precision tools to the largest-known types of boring mills, lathes, planers, etc., and to the plate shop, with its numerous bending rolls, shears, punches, hydraulic presses, etc., that must be able to handle plates and shapes of the largest-known size. This brief statement clearly shows how closely linked is the shipyard with the machine



NILES-BEMENT-POND HYDRAULIC GARBOARD BENDER.

tool designer and builder, and the following brief mentions give some idea of recently designed shipyard tools:

A useful horizontal boring, drilling and milling machine, built by the Niles-Bement-Pond Company, New York and

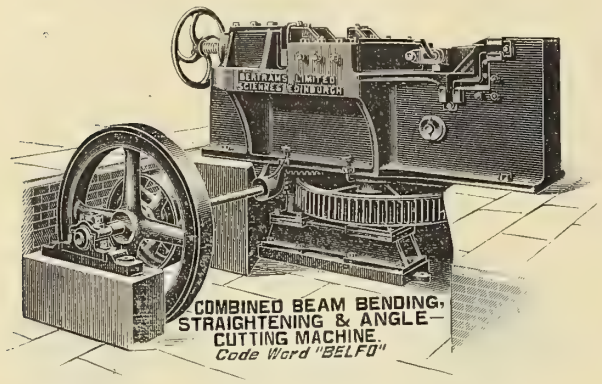


PERKINS & CO., LTD., POWER HACK SAW.

London, is shown at work on a low-pressure marine engine cylinder. All the facing, milling, boring, drilling and tapping operations on this cumbersome casting are done at one setting.

The wide range of horizontal and vertical adjustment of this type of machine, together with the large number of variable spindle speeds and feeds, makes it indispensable for this class of work.

Heavy plate-bending rolls were installed in the plate shops of the Newport News Shipbuilding & Dry Dock Company by Niles-Bement-Pond Company, capable of bending cold plates up to 32 feet wide and 1½ inches thick or their equivalent.



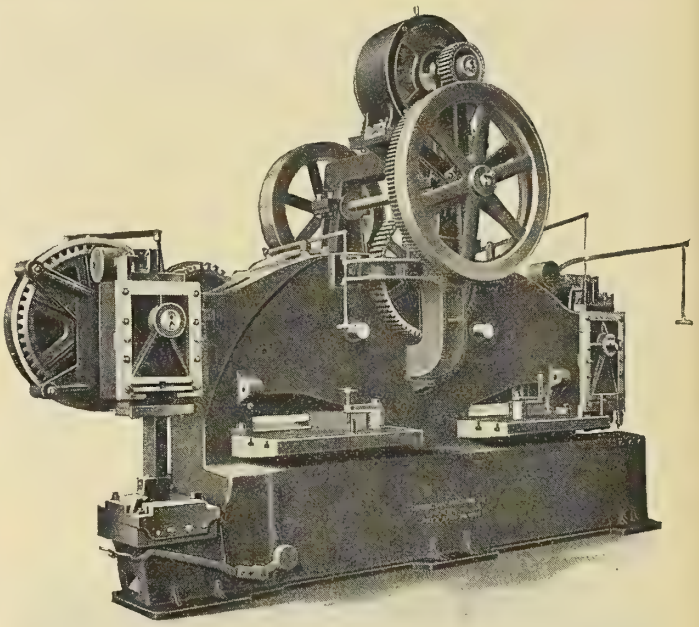
BERTRAM, LTD., BEAM BENDING AND ANGLE CUTTING MACHINE.

They have been used to bend heated nickle steel plate up to 2½ inches thick.

A plate-planing machine is a typical example of one of the fundamental machine tools built for shipyards by the Niles-Bement-Pond Company The heavy power splitting shears to be found in every plate shop cut the plate to the approximate width required, after which the plate planer is relied on to produce a square straight edge. The carriage is driven by a heavy screw, the direction of rotation of which is changed automatically at the end of each stroke. The drive is by wide open and crossed belts on pulleys of large and equal diameter. The tool slides on the carriage are arranged for two tools, which alternate in cutting the plate with the change in direction of the stroke.

A 125-inch crank shaft lathe designed for turning the heaviest crank shafts is another Niles-Bement-Pond tool. It is 26 feet long between faceplate and tailstock center, the diameter of the journal being 17¾ inches and that over the rings 27 inches. The maximum diameter which can be swung over the bed is 125 inches, while 108 inches can be swung over the carriages. This machine is shown at work on the thrust bearing of a large shaft on editorial page, 107.

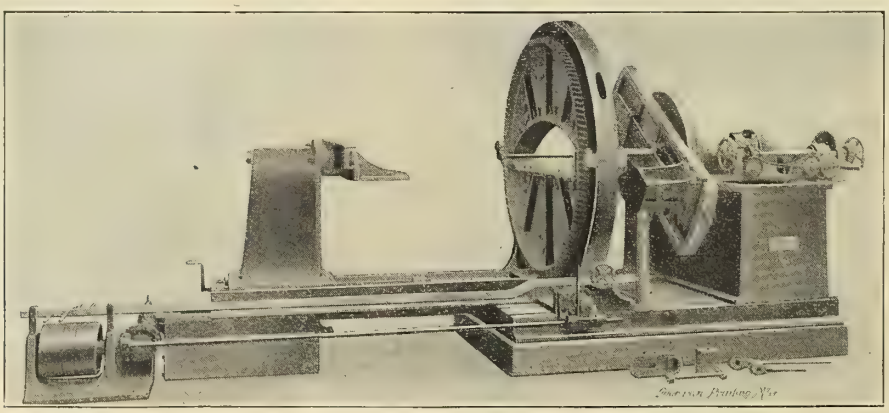
The Niles-Bement-Pond hydraulic garboard bending machine is capable of turning out a very large variety of plate shop work entering into the construction of steel vessels, such as bending and forming keel plates, garboard streaks, sponsons, deck plates, etc. The machine is capable of exerting a pressure of 200 tons, with a water pressure of 1,500 pounds per square inch. Hot plates up to 3 inches thick and the length of the bending beam can be handled. The bending beam will carry one or more forming dies, with a length of 18 feet.



UNIVERSAL SHEAR FOR CHANNELS, ANGLES AND PLATES. MADE BY THE COVINGTON MACHINE COMPANY.

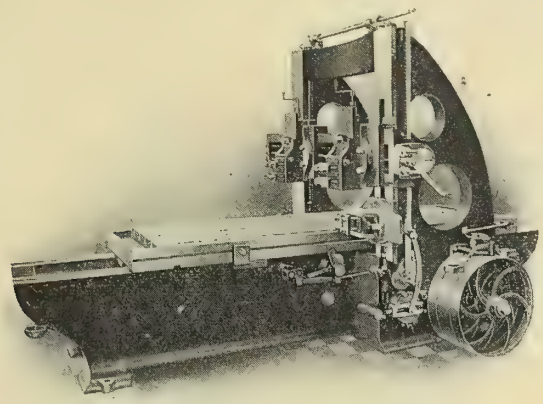
This company sends upon request a 20-page fully illustrated folder of shipyard tools.

A machine that can cut channels and angles is made by the Covington Machine Company, Covington, Va. It is a combination tool. The feature of this shear lies in the combination of four tools in one. It is provided with a coping attachment at one end, a plate shear at the other, and two angle shears in the center of the frame. These angle shears operate at an angle of 45 degrees, thus securing a vertical and horizontal shearing action. Each shear is controlled by its own clutch, and the machine may be operated by different groups of men, all working at the same time without interfering with



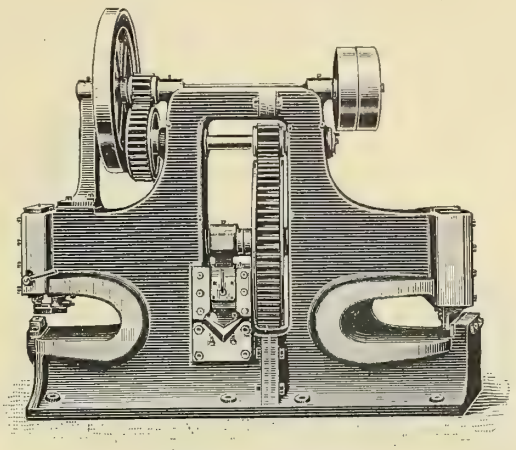
GREENWOOD & BATLEY TURNING, BORING AND DRILLING MACHINE.

each other. The angle shears in the center have a capacity for cutting channels up to 15 inches by ¾ inches, and 6 inches by 6 inches by 1 inch, or 8 inches by 8 inches by ¾ inch angles. The plate shear has a capacity for material up to 1 inch in thickness. Channels or angles may be cut either square or at an angle for mitering.



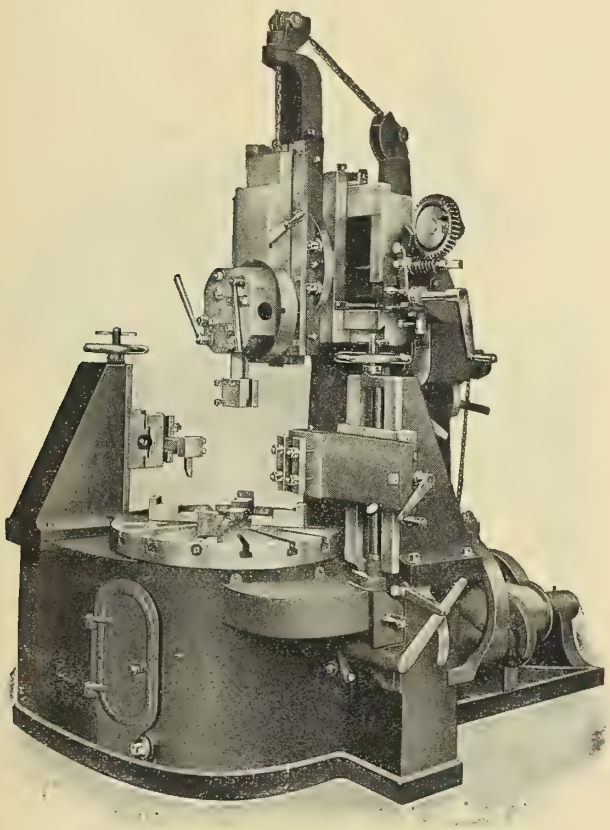
C. REDMAN & SONS 3-FOOT SQUARE PLANING MACHINE.

Messrs. Scott Bros., Halifax, have placed another design of punching and shearing machine on the market. It is a beam-bending machine or straightener, combined with punching; punching plates at the one side while bending or straightening T, L, H, U sections at the other end. The machine is capable of punching 1-inch holes through 1-inch plates, with gap 28 inches deep, and at the other side it bends or straightens sections up to 12 inches by 12 inches. In addition the punching side, besides doing ordinary punching, may be arranged for punching section iron with loose interchangeable blocks, so that H iron, U or T's may be punched through the webs or flanges.

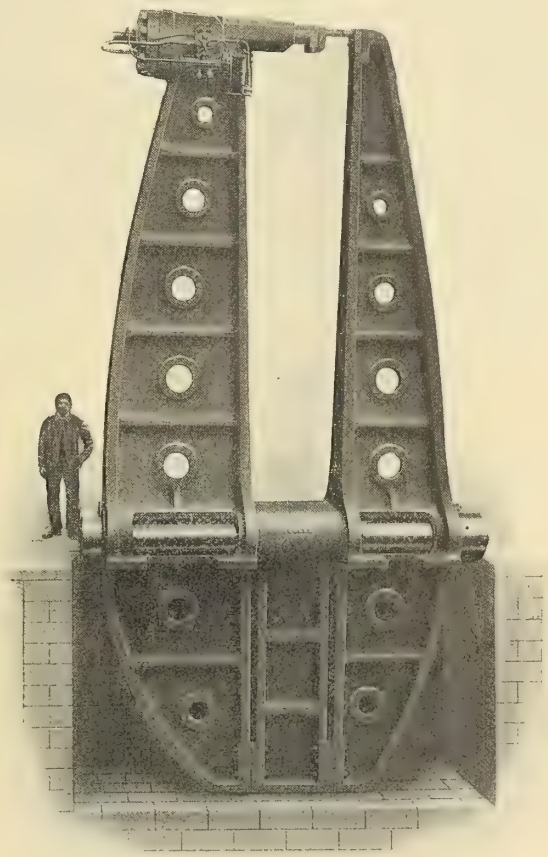


WARD, HAGGAS & SMITH DOUBLE-ENDED PUNCHING AND SHEARING MACHINE.

An improved beam and angle-bending and straightening and angle-cutting machine is made by Messrs. Bertrams, Ltd., Edinburgh. This machine is of the under-driven type, with the gearing beneath the floor. Beams up to 12 inches by 6 inches can be bent or straightened at one end of the machine, and angles up to 8 inches by 8 inches can be cut at the other end. The beam-bending slide carries two bending blocks or hammers, arranged at a suitable distance apart, by which the

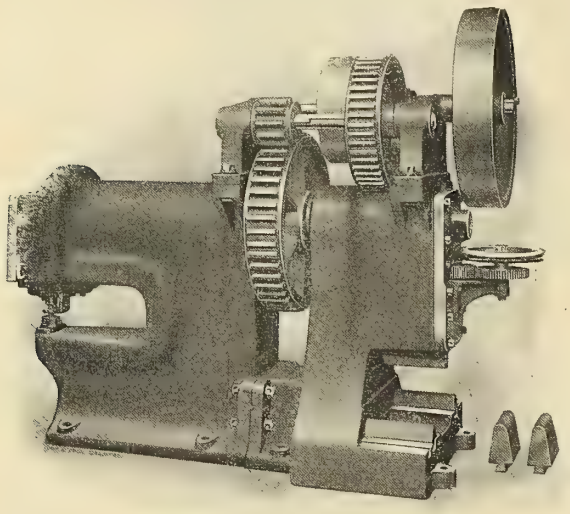


G. WILKINSON & SONS VERTICAL TURNING AND BORING MILL.



HENRY BERRY & CO. FIXED RIVETER.

beams are bent or straightened over a third block, which is adjustable by screw and hand wheel. The other end of slide is connected to a heavy cast steel lever carrying angle-cutting blade, the stationary blades for angle cutting being fitted into a suitable recess in main casting. A tumbler disengaging gear is applied to the angle-cutting lever, so that angles may be

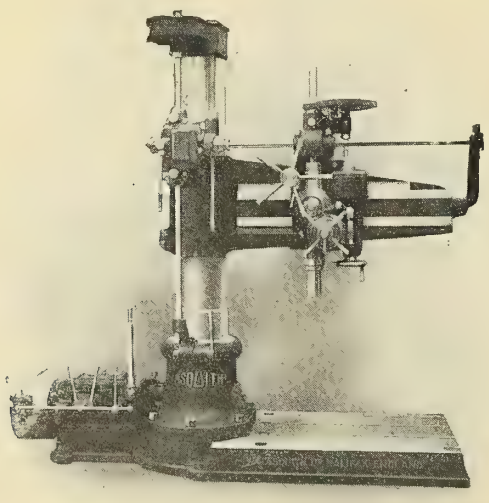


SCOTT BROS. PUNCHING AND SHEARING MACHINE.

easily set in exact position under the blade before being cut off.

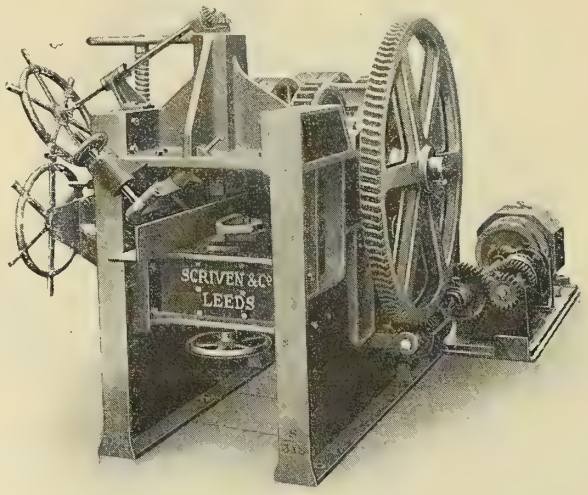
A portable hydraulic angle or ship frame bending machine is manufactured by the Leeds Engineering & Hydraulic Company, Ltd., Rodley. This machine is capable of exerting a total pressure of 19 tons and can be made to suit any working pressure. The section to be bent is placed on the floor plate, which is provided with a number of holes; the operator then pushes the machine up to the section, the fixing bolt is dropped in the nearest hole, and the valve, which can be actuated by either hand or foot, is opened to pressure and the ram advances to bend the section into the desired shape.

F. Pratt & Company, Ltd., Halifax, manufacture an improved crank-geared shaper. The ram slides freely in its guide by means of a crank motion, which gives a quick return



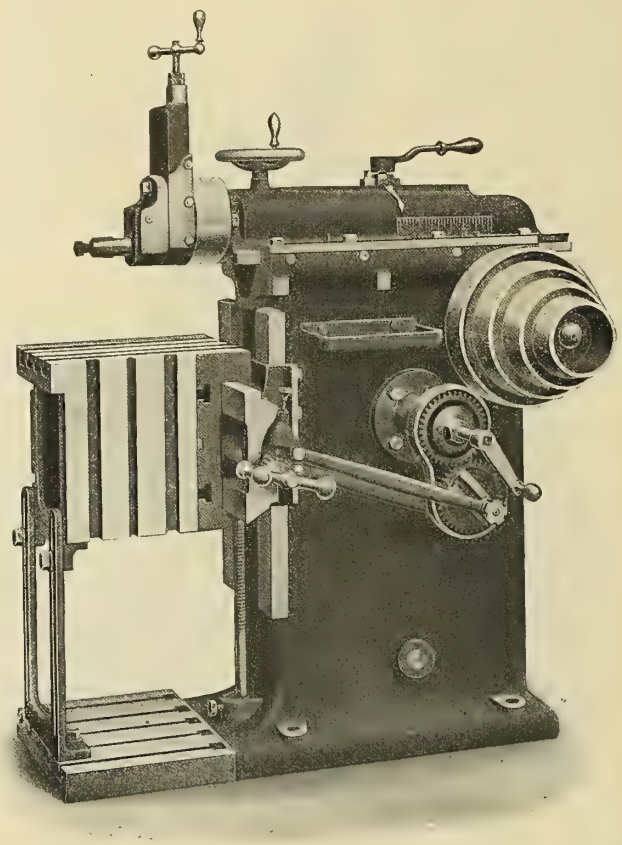
WILLIAM ASQUITH, LTD., RADIAL DRILLING MACHINE.

stroke. Adjusting strips are provided for taking up all wear. The stroke and also the position of the ram can be altered while the machine is running. A graduated rule and indicator is fitted to show the length of the stroke at a glance. Shafts can be passed through the body of machine under the ram for grooving and cutting keyways.



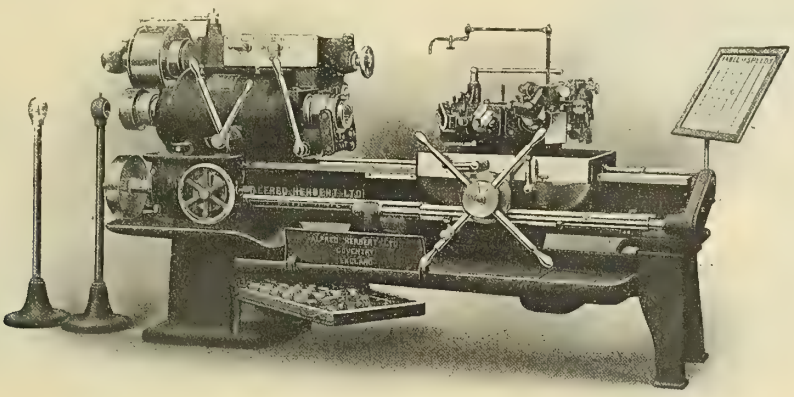
SCRIVEN & CO. ANGLE BAR PLANER.

White's patent angle-bar planer is manufactured by Messrs. Scriven & Company, Leeds. The machine is used for planing off the round edges of angle bars to leave a square edge for calking. It is capable of dealing with any size of angle bars up to 12 inches by 12 inches by 1 inch thick, planing both legs of the

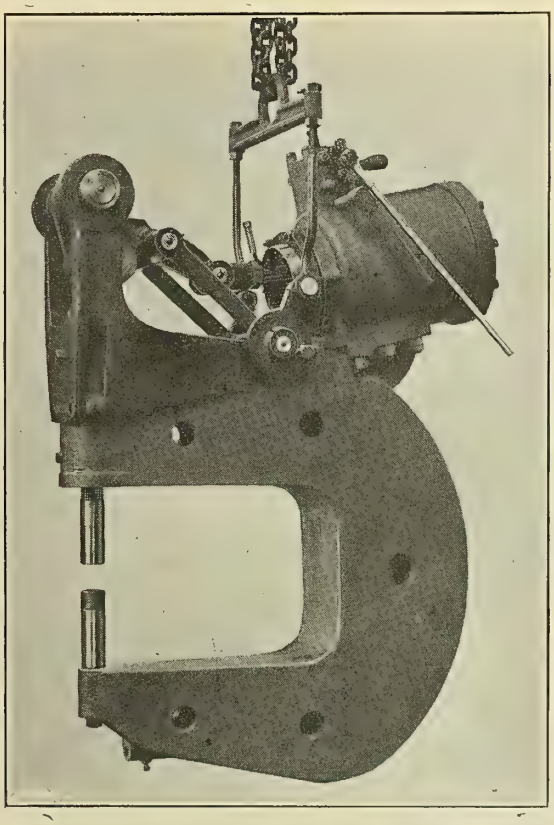


F. PRATT & CO. IMPROVED CRANK-GEARED SHAPER.

bar simultaneously. The angle bar is fed through the machine by strong steel friction rollers and requires no setting, but can be planed just as received from the rolling mills. The gripping pressure of the feed rollers is obtained by a system of levers operated by strong screw with large hand wheel and safety spring device. All the friction rollers are positively driven by spur gears from one main-driving shaft. Angle-bar planers of the same general design, but with capacity for angles up to 10 inches by 6 inches only, have been in use for many years in the British and principal foreign navy yards, also in many of the most important contractors' yards.



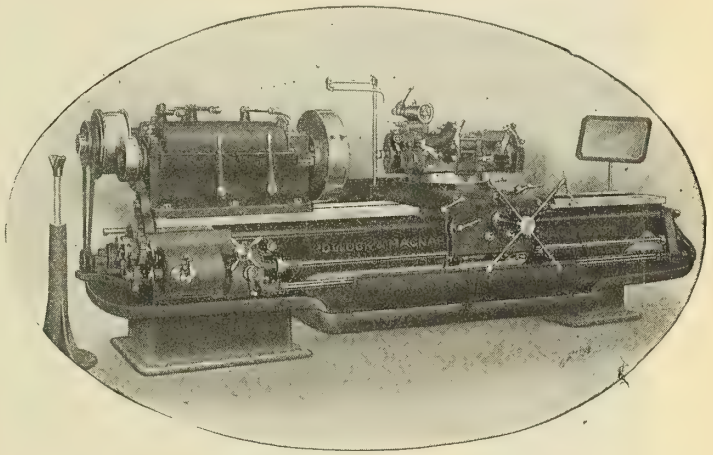
ALFRED HERBERT, LTD., HEXAGON TURRET LATHE.



J. BENNIE & SONS PNEUMATIC RIVETER.

A combined beam-bending angle-cutting and vertical punching machine is built by Messrs. Craig & Donald, Ltd., Johnstone. This type is arranged with the hammers adjustable as to their centers by means of right and left hand screws. The adjustment for the various depth of beams is made from the hand wheel at the end of the machine actuating the gear which lengthens or shortens the moving ram which carries the striking hammer. This arrangement allows for the straightening of the smallest section of bars. For vertical punching a special steel die holder is arranged.

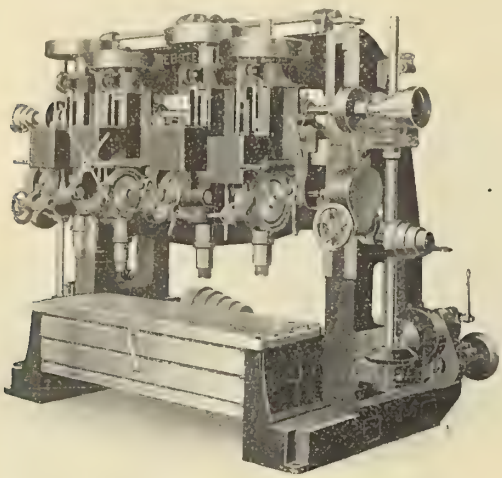
G. Wilkinson & Sons, Keighley, have a new model vertical turning and boring mill made in two sizes, 2 feet 6 inches and 3 feet. The chief improvements claimed are the adjustable automatic knock-off for the turret head traverses, the piston-driven feeds, and the method of locking the turret head. There are three tools, all of which can be in operation at the same time.



POLLOCK & MACNAB "APOLLO" HEXAGON TURRET LATHE.

A type of pneumatic riveting machine which has found favor with engineers of the United States is now being manufactured in this country by Messrs. James Bennie & Sons, of Cardonald, Glasgow. The machine, known as the Hanna riveter, made by the Hanna Engineering Company, Chicago, is claimed to be free from certain well-known defects, notably the variation in pressure, and to approximate to the direct-acting hydraulic type in regard to certainty of operation. The design of the machine in this case enables the closing of the rivets

to be effected at constant pressure in spite of any slight variation in length, and a further advantage of the machine is that it requires only 80 pounds to 100 pounds pressure, and that the

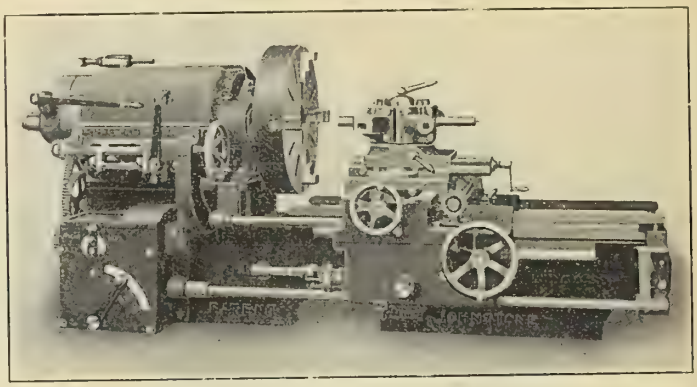


WEBSTER & BENNETT DRILLING, TAPPING AND BORING MACHINE.

employment of an exhaust pipe is obviated. As compared with the hydraulic machine the consumption of power is stated to show an economy.

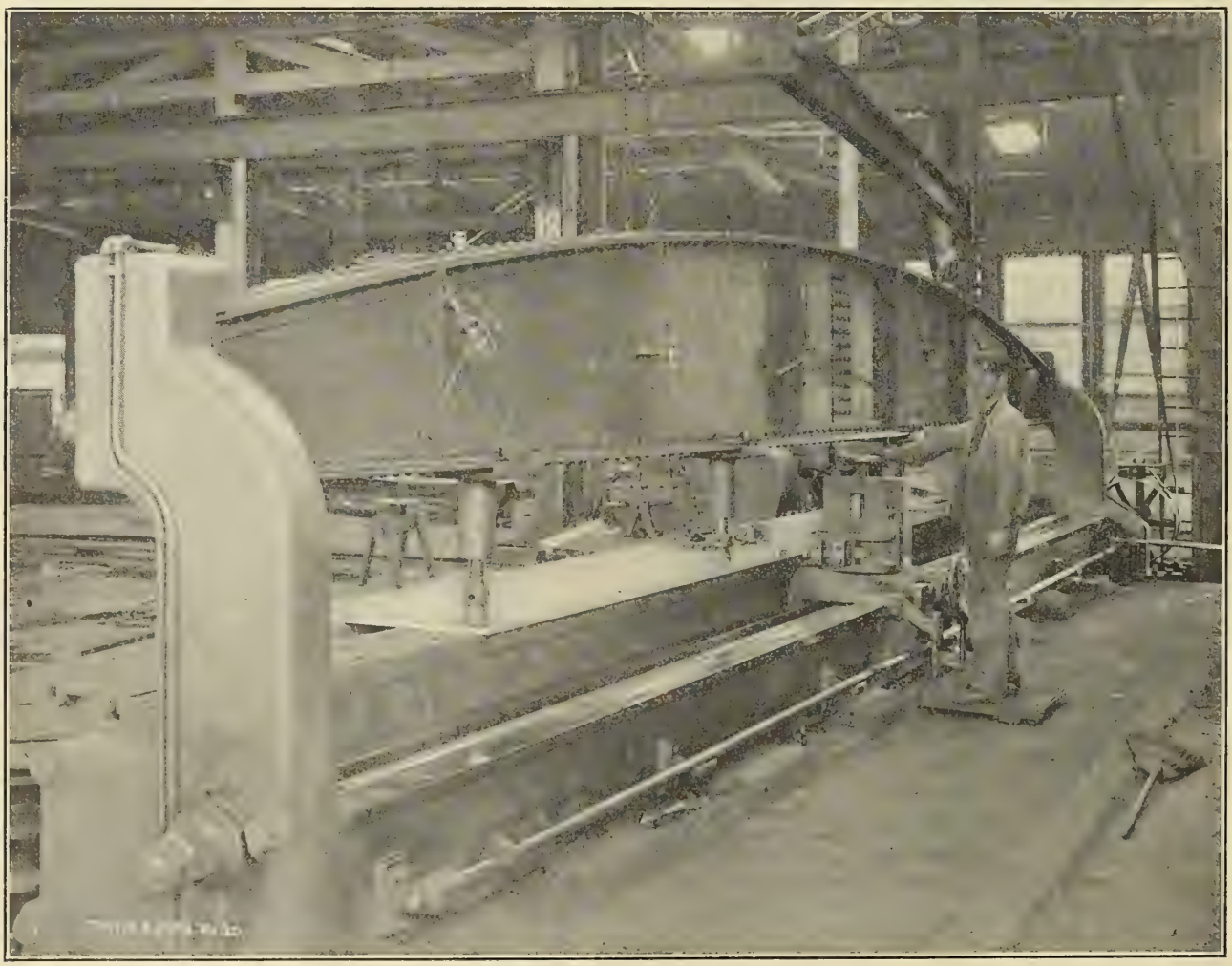
A high-speed central thrust girder rotary drilling machine is manufactured by William Asquith, Ltd., Halifax. Some of the features of this drilling machine are that the spindle slide is so arranged that the thrust is central, entirely overcoming side-twisting strains, and the slide can be easily and quickly traversed along the arm and securely locked in any position.

Alfred Herbert, Ltd., Coventry, manufacture a hexagon turret lathe especially designed for utilizing to their limit



J. LANG & SONS CAPSTAN LATHE.

modern cutting tools of high-speed steel on work made from steel, iron or bronze bars. Some of the new features of this turret lathe are the single-pulley head in place of the cone pulley—a so-called "roller steady" turner, which removes the metal much more rapidly than was previously possible, and a feed motion that allows of a quick change of feed.



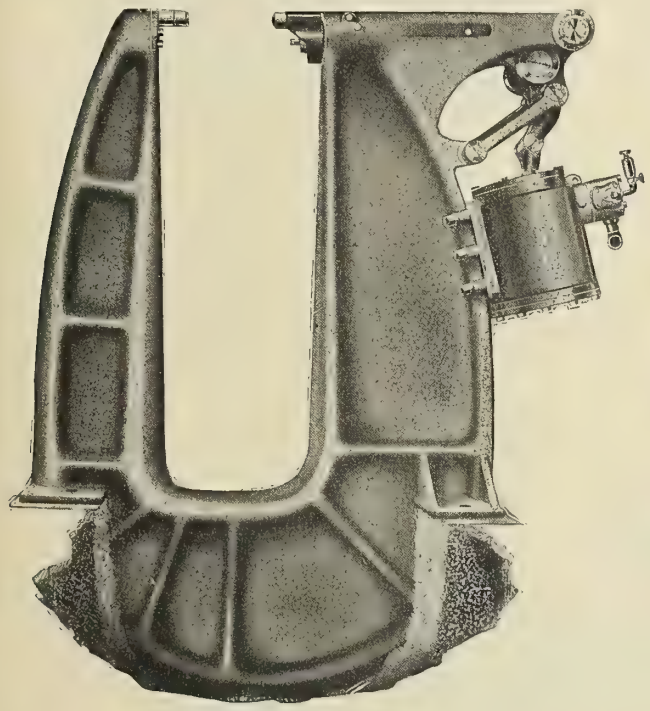
NILES-BEMENT-POND PLATE PLANER.

Messrs. John Lang & Sons, Johnstone, make a specialty of lathes, and have recently redesigned their entire line to meet the demands of high-speed steel. One of the special features of these lathes is a variable speed drive that has a gradual progression. With this form of drive the correct speed may be had for turning any diameter within the capacity of the lathe.

A four-spindle drilling, tapping and boring machine is manufactured by Webster & Bennet, Ltd., Covington. This machine is designed for boring two separate pieces of work at once, and for this reason the right-hand pair of heads is independent of the left-hand pair, and the machine is suitable for operating on four separate pieces of work.

Messrs. Perkins & Company, Ltd., Leeds, are marketing self-acting, sliding, surfacing, and screw-cutting lathes, valve seat planing machines, slotting machines, shaping machines, disk grinders, etc. The shaping machine has an automatic variable feed motion, which is instantly reversible, and the toggling is kept horizontal by a sliding tenon.

A machine is manufactured by Messrs. Robert S. Allan & Company, Gateshead-on-Tyne, for core boxes and patterns, as well as all kinds of carving at various angles, half-lapping, molding, raised and sunk paneling, etc. The machine consists of two parts mounted on a common bedplate, the fixed



HANNA ENGINEERING CO. BOILER RIVETER.

pedestal carries the horizontal spindle and is bolted to the bedplate. The second part forms a work carrier and is so designed that it embodies universal movement.

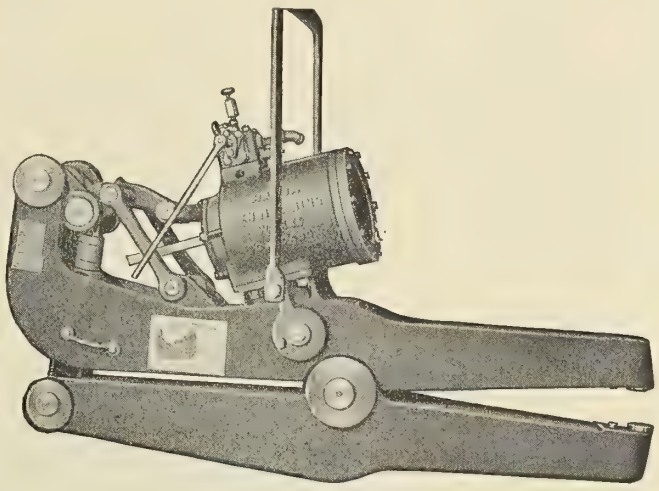
The high-speed planer, manufactured by Bateman's Machine Tool Company, Ltd., Leeds, has two special features—the sliding rack and the flywheel drive. The sliding rack effectually absorbs the shock of reversal in buffer springs, which instantly gives back to the table after the reversals stored momentum. The flywheel drive utilizes the stored energy of the heavy loose pulleys in securing exceptionally prompt reversals of the table.

Messrs. Loudon Bros., Ltd., Clyde Engineering Works, Johnstone, N. B., are builders of a high-speed planing machine from which one or two speeds can be obtained by a belt drive and three or six speeds through a gear box.

Messrs. Davis & Primrose, Etna Engine Works, Leith, are putting on the market a patent-beveling machine. This machine draws the bar out of the furnace and does the beveling when the bar is at its best heat. It smooths down the rough edges of the rivet holes, so that the rivet head gets close up at the neck. The time occupied by the beveling is short, so that the bar when it has left the machine is sufficiently hot to be turned without reheating.

A self-contained high-speed planing machine is built by Messrs. C. Redman & Sons, Halifax. These planers have four cutting speeds, ranging from 30 to 60 feet per minute, the speed changes being made without difficulty when the machine is in operation. This has the advantage of allowing the operator to run the machine at, say, a speed of 50 feet per minute on cast iron where the frailty of the casting makes a light cut at quick speed better than a heavier cut at lower speed, and also for second cuts preparatory for a finishing cut. The speeds are changed from the floor by means of the pulley chain. The change can be easily and quickly made, the rate of return of the toggle remaining constant.

The Hanna Engineering Works, Chicago, Ill., have developed a pneumatic riveter, which operates through a combination toggle and lever action so arranged that the rapidly increasing tonnage developed during the action of the former is maintained practically uniform by the lever action through a



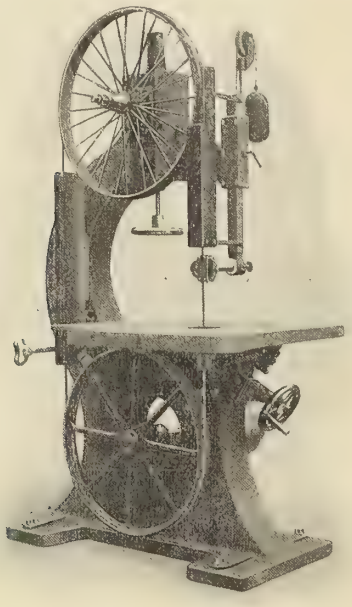
HANNA ALLIGATOR RIVETER.

considerable portion of the stroke. This machine goes through its toggling action during approximately the first 6 inches of piston stroke and carries the die through practically 3½ inches of its travel. At this point the machine has reached its rated pressure and the toggling action is automatically changed to the action which is maintained for the balance of the piston stroke, thereby maintaining the rated tonnage. These riveters are also manufactured by the Clyde Engine Works, Glasgow.

Messrs. Ward, Haggas & Smith, Keighley, Yorks, manufactures double-ended punching and shearing machines driven by double-purchase gearing shrouded to pitch line, pulleys of large diameter, the loose pulley being provided with improved lubricating arrangement, consisting of a hollow perforated bush which runs on the shaft and contains a month's supply of lubricant. In the 1-inch machine the flywheel is supported by an outside standard.

The accompanying illustration shows one of the very latest types of fixed riveters for shipyard, locomotive boiler and similar work, and was made by Messrs. Henry Berry & Company,

Ltd., of Leeds. The riveter has a gap of 17 feet 6 inches, and has three powers for closing rivets, viz., 33, 66 and 99 tons, and is also fitted with the latest valve arrangement when desired, by means of which the pressure is held on the rivet

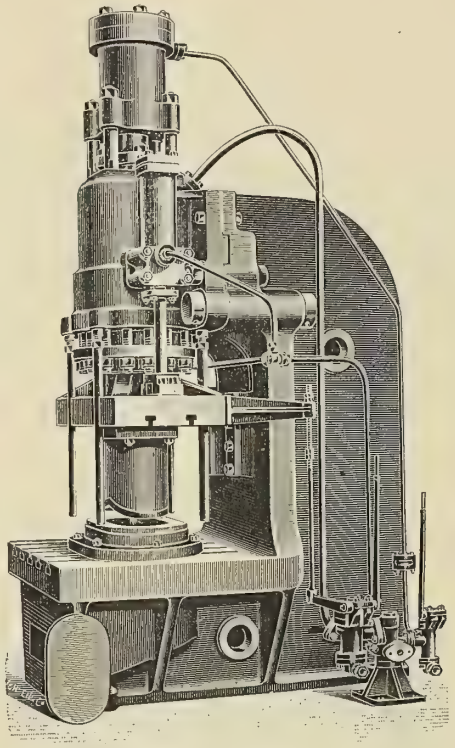


J. SAGAR & CO. IMPROVED BAND SAWING MACHINE.

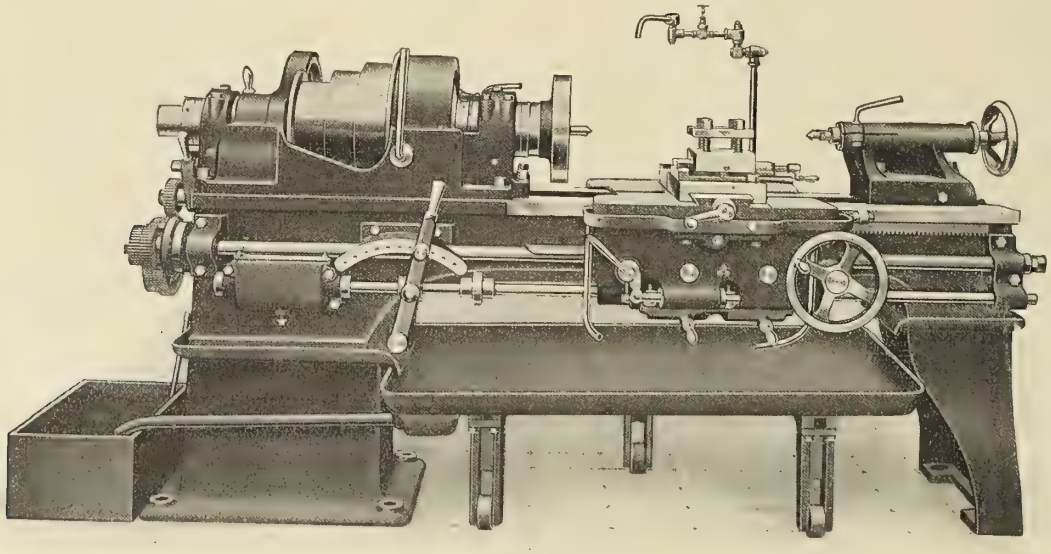
for a time and cannot be taken off by the operator until it has been on for this period, thus insuring that each rivet gets the full power of the machine. The arms of the machine are of cast steel, and are held together by means of massive forged steel bolts with steel nuts. All the cylinders are gun-metal lined.

Messrs. Greenwood & Batley, Ltd., Leeds, make a combined machine for drilling, turning, etc., propeller blades, suitable for cutting off the riser or dead head, facing back of flange, turning edge of flange either straight or at any angle up to 45 degrees.

The "Apollo" hexagon turret lathes are manufactured by Messrs. Pollock & Macnab, Manchester. The head stock is of the single-pulley type, with gearing running in an oil bath, and has sixteen direct-spindle speeds from the line shaft. The jaws are in four parts and the chuck itself can be opened or closed while the lathe is running. The automatic feeds are actuated through an apron of the double-frame type, so that the feed wheels and shafts are supported in two bearings and not overhung. A special feature is that the worm drive for the apron has ball thrust, reducing the strain and wear on the feed wheels.



MUSGRAVE BROS. HYDRAULIC PRESS.



C. REDMAN & SONS SPECIAL LATHE.